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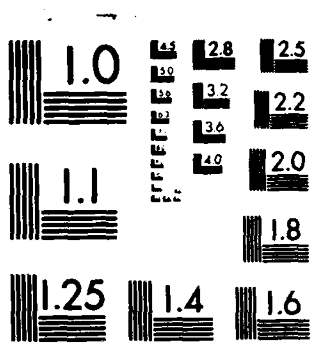

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ARCHAEOLOGICAL AND PALEONTOLOGICAL
INVESTIGATION AT KALAELOA (BARBER'S POINT)
HONOULIULI, 'EWA, O'AHU ISLAND
FEDERAL STUDY AREAS 1a AND 1b, AND
STATE OF HAWAII OPTIONAL AREA 1

by
Hallett H. Hammatt, PhD.
William H. Folk II, B.A.
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by
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Lawa'i
July 1981

ARCH 14-115

The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the United States Army Corps of Engineers.

ABSTRACT

Archaeological testing and salvage excavations were conducted in three (3) adjoining parcels, designated Study Areas 1a, 1b (Federal) and Optional Area 1 (State) in conjunction with plans for a deep draft harbor in Honouliuli ahupua'a, 'Ewa District, O'ahu. The study areas are part of a karstic landscape formed on an extensive raised coral reef of Pleistocene age which is highly dissected by solution sinks. Of 148 archaeological sites, 88 were selected for testing and 26 selected for excavation on the basis of lack of disturbance and occurrence of stratified cultural deposits. The excavations concentrated on habitation sites (17) for the purpose of systematic collection of data on 1) interior and exterior features, 2) disposal pattern of artifacts and midden materials in relation to features and site configuration and 3) artifact and midden assemblages. The results of this analysis formed the criteria for intersite comparisons and the empirical grouping of habitation sites into 1) shelters, 2) nuclear sized family dwellings and 3) family complexes or kauhale. These groups comprise a developmental sequence of human settlement. A reliable quantitative chronology was obtained for two (2) sites one of which ranges from 550 ± 75 to 1760 ± 21 basaltic glass years (Site 9682) and the other (Site 2731) 1080 ± 96 basaltic glass years A.D. Paleontological study of fossil avifauna show that the limestone solution sinks and surrounding terrain were a major habitat of many fossil birds. The extinction of over 30 of these species is probably related to habitat destruction by prehistoric Polynesians and their introduced vertebrates (pig, dog, rat) and in later phases by direct exploitation. Stratigraphically the extinction occurred at or near the Polynesian and post-contact introduction of landsnail species and the proportional decrease in native extinct populations of snails. Decreased vegetation cover and increasing aridity are inferred from successive changes in landsnail assemblages. Kalaeloa may have been one of the first areas utilized by early Polynesians on O'ahu. The varied avifauna may have been the initial attraction to the area in conjunction with the rich marine resources. This was later supplemented by planting of root and tree crops in mulched sinks. Historically

the land was virtually abandoned by permanent occupants, overgrown with <u>kiawe</u> and used for grazing.

The latest systematic land use was the construction of adjacent Camp Malakole at the beginning of World War II. Military operations occurred in the study area and along with bulldozing, <u>kiawe</u> cutting and quarrying has greatly impacted the landscape and the archaeological remains.

ACKNOWLEDGEMENTS

We would like to thank the field crew, Mr. Douglas Kahaneli Borthwick, Mr. Virgil W. Meeker, Mr. Stephan D. Clark, Mr. Gerald Kamalu Ida, Miss Cora H. Motoyama, Mr. Robert A. Albert, Mr. David Shideler, and Mr. Joseph L. Ka'auwai for their cooperative and efficient work. Special thanks is extended to Douglas Borthwick and Virgil Meeker for their skills and perseverance during the initial relocation of sites in the pitted and densely vegetated terrain where every step was treacherous. Mrs. Betty Muagututi'a Ching performed the laboratory analysis and her efforts are gratefully acknowledged. Grateful acknowledgement is also extended for the special skills of Mr. Charles M. Hiramoto and Mr. Brian P. Donahue, who prepared all of the final maps and figures.

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Captain Robert A. Albert, USMC (Ret.) spent many days investigating leads, collecting information and compiling an excellent report on World War II Camp Malakole. His efforts and continued interest are greatly appreciated. Mr. Virgil Meeker was instrumental in providing some of the background for this research.

Acknowledgement is extended to Dr. Patrick V. Kirch and Dr. Carl C. Christensen from the Bernice Pauahi Bishop Museum for conducting the field work and laboratory analysis of the molluscan fauna for paleoecological studies.

We are grateful to the United States Army Corps of Engineers personnel, Dr. James Maragos, for his expedient and courteous assistance throughout the project, to Mr. David Sox for his valuable assistance in reconstructing the history of military activities at Barber's Point and to Ms. Elaine Tamaye, U.S. Army Corps of Engineers Project Engineer.

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We thank Mr. Ellis Cross for his friendly chats during which he shared with us his knowledge of the sites and his archaeological finds while diving off the coast near the study area.

Grateful acknowledgement is also extended to the personnel of Chevron, Inc., who kindly allowed us the use of their telephone and their well-kept grounds, thereby providing us with shady comfort during our noon meals; and to personnel at the Texaco Service Station at Makakilo, who kindly assisted us when a field vehicle failed.

Dr. William "Pila" Kikuchi of Crafts Hawaii prepared the thin sections of basaltic glass specimens and Beta Analytic, Inc. analyzed the charcoal samples. Hydration measurement was accomplished by the Geology and Hydration Rind Dating Department of Archaeological Research Center Hawaii, Inc. Their technical skills and expedience are acknowledged.

We gratefully acknowledge Mrs. Diane K. Shimizu and Mrs. Cynthia J. Shklov for typing this report. To Mr. Francis K. W. Ching, President of Archaeological Research Center Hawaii, Inc., who assisted in directing this study through continuous advice and support, <u>mahalo nui loa</u>.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

Page

Page

Page

Page

Page

Page

Page

Page

Page

LIST OF TABLES

INTRODUCTION

This report presents the results of archaeological and paleontological testing and salvage excavations in Federal Study Areas 1a and 1b and in State of Hawaii Optional Area 1 in Honouliuli *ahupua'a*, 'Ewa district, O'ahu Island (Figures 1 and 2). This work was performed in compliance with applicable federal regulations, listed in the Scope of Work (see page 6) as a result of recommendations made following archaeological surface surveys of the location of the proposed Barber's Point Deep Draft Harbor and its support facilities. All the archaeological sites containing cultural remains were previously recorded during the surveys. An unrecorded wet sink was identified during this study and was assigned a permanent site number. Two noncultural sinks selected for paleontological salvage were also assigned permanent numbers..

The study areas are adjacent to one another and are situated on the *mauka* side of Malakole Road directly across from the Chevron Oil refinery and the World War II military Camp Malakole at Campbell Industrial Park (Figure 3). The northern boundary of the study areas is adjacent to the existing limestone quarry area and the eastern boundary is adjacent to existing sugarcane fields.

Relocation and testing of the archaeological sites was completed first. Archaeological testing was conducted to determine the presence of stratigraphic evidence of human occupation at each site. The results are summarized in Table 1. During the testing phase, presence and approximate density of avifaunal remains were noted and sites with relatively dense bird bone deposits were inspected later by Dr. Storrs Olson of the Smithsonian Institution (Table 2). All bird bone material from the sinks suggested for paleontological testing was identified by Dr. Olson as *Pterodroma phaeopygia* (dark-rumped petrel). This is probably the most useful material (superior even to the scarce basaltic glass) for establishing a relative chronology for the archaeological features in the entire 'Ewa plain. (Refer to Dr. Olson's findings in Appendix II).

The United States Army Corps of Engineers, requested landsnail studies as part of the paleontological investigation. This included the collection and analysis of six column samples to determine the usefulness of terrestrial gastropods (landsnails) in paleoecological reconstruction (see Appendix II; also refer to pp. 204 [Barber's Point Perspective]).

Results of the testing phase determined that only the habitation sites had the quantitative and qualitative potential for yielding archaeological material necessary in determining patterns which reflect the cultural strategies of the human inhabitants. Descriptions of the salvaged archaeological sites and a summary of the excavation results, including scale maps, graphic analysis of midden and artifact distribution, and descriptions of strata are presented separately in this report. The complete artifact assemblage is cataloged in Appendix IV and the artifacts and midden are discussed in separate sections following the excavation results. A master list of archaeological and paleontological sites with all previous site numbers is presented in Appendix IV.

Charcoal samples from four habitation sites were submitted to Beta Analytic, Inc. of Florida for radiocarbon age analysis; and 22 basaltic glass flakes were submitted to Crafts Hawaii, Kaua'i, Hawaii for thin sectioning and mounting. Hydration rind measurements were then taken at Archeological Research Center Hawaii, Inc. laboratory facilities. The results of these charcoal and basaltic glass age analyses are summarized separately after the artifact analysis section. An historic account of the military presence in the study areas and adjacent Camp Malakole is presented in Appendix III. All appendices have been edited for inclusion in this report. For a short summary and statements on the archaeology and paleontology of Barber's Point, we refer the reader to the Summary of Results on Page 14 and the Barber's Point Perspective on Page 204. The spelling of Barber's Point used in this report is consistent with that used on early maps of the area (Lewis 1970:Figures 2 and 3).

Plan views and grid plans of every site excavated are shown in the Archaeological Excavation - Excavation Results section. For plan views of spacially related sites see Davis (1978).

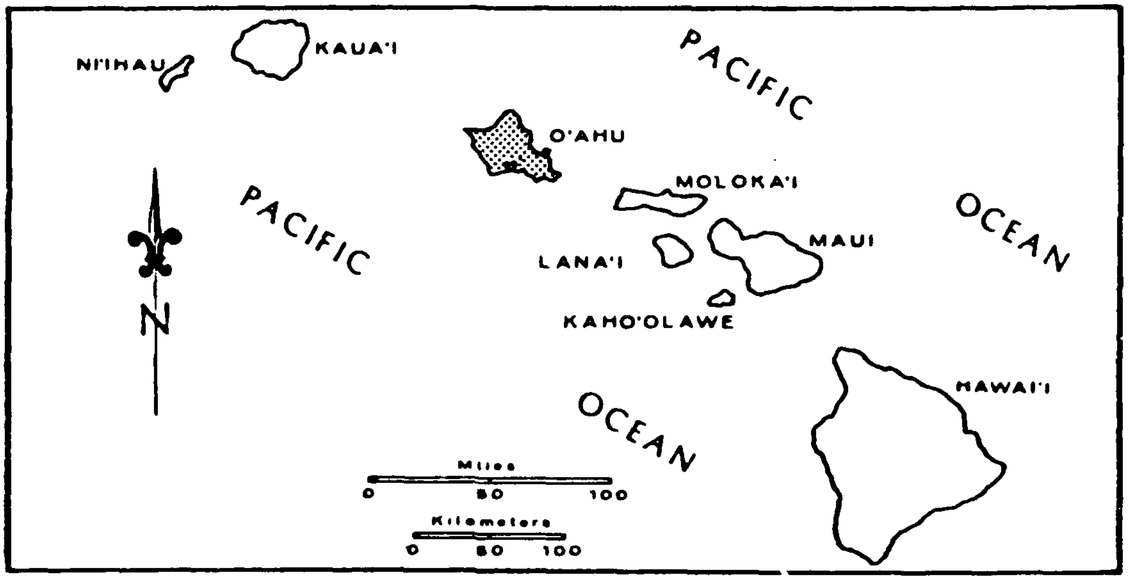

FIGURE I
Map of the State of Hawai'i

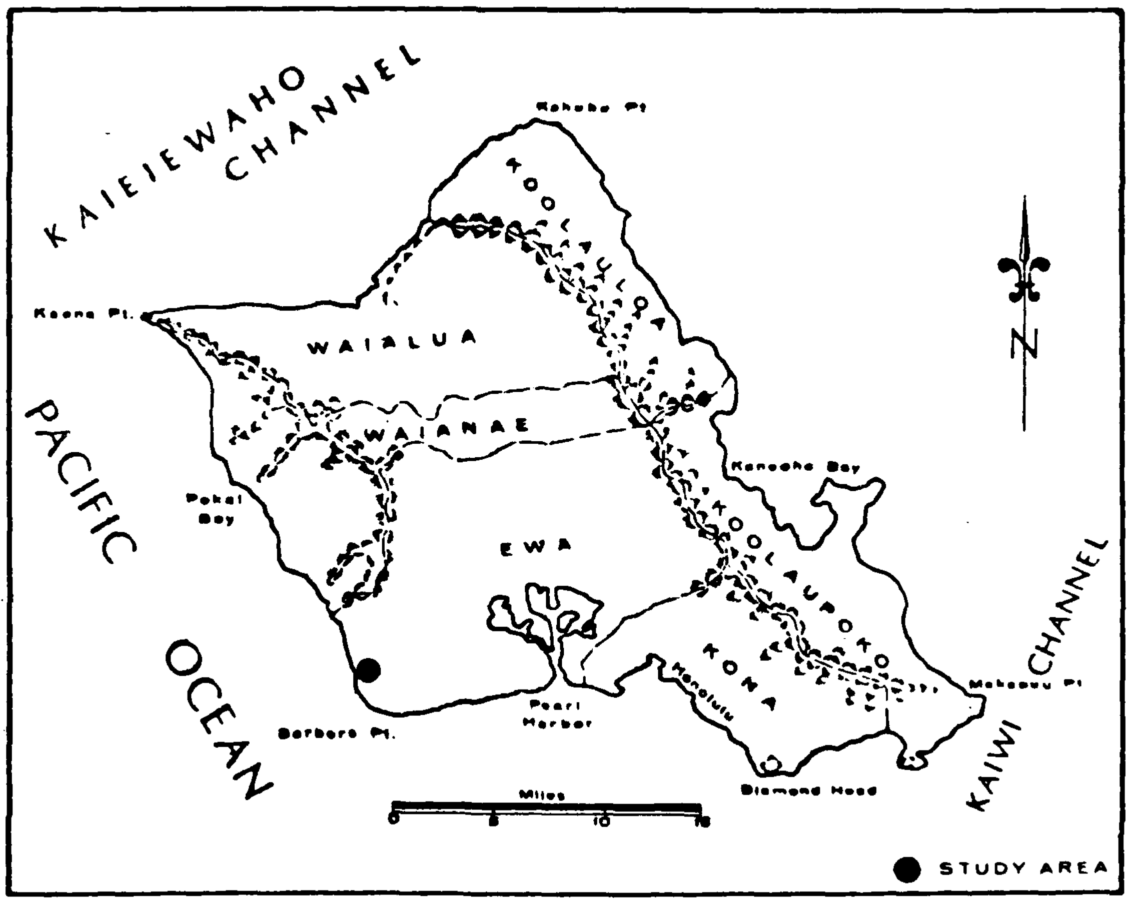

FIGURE 2
General Location Map, O'ahu Island

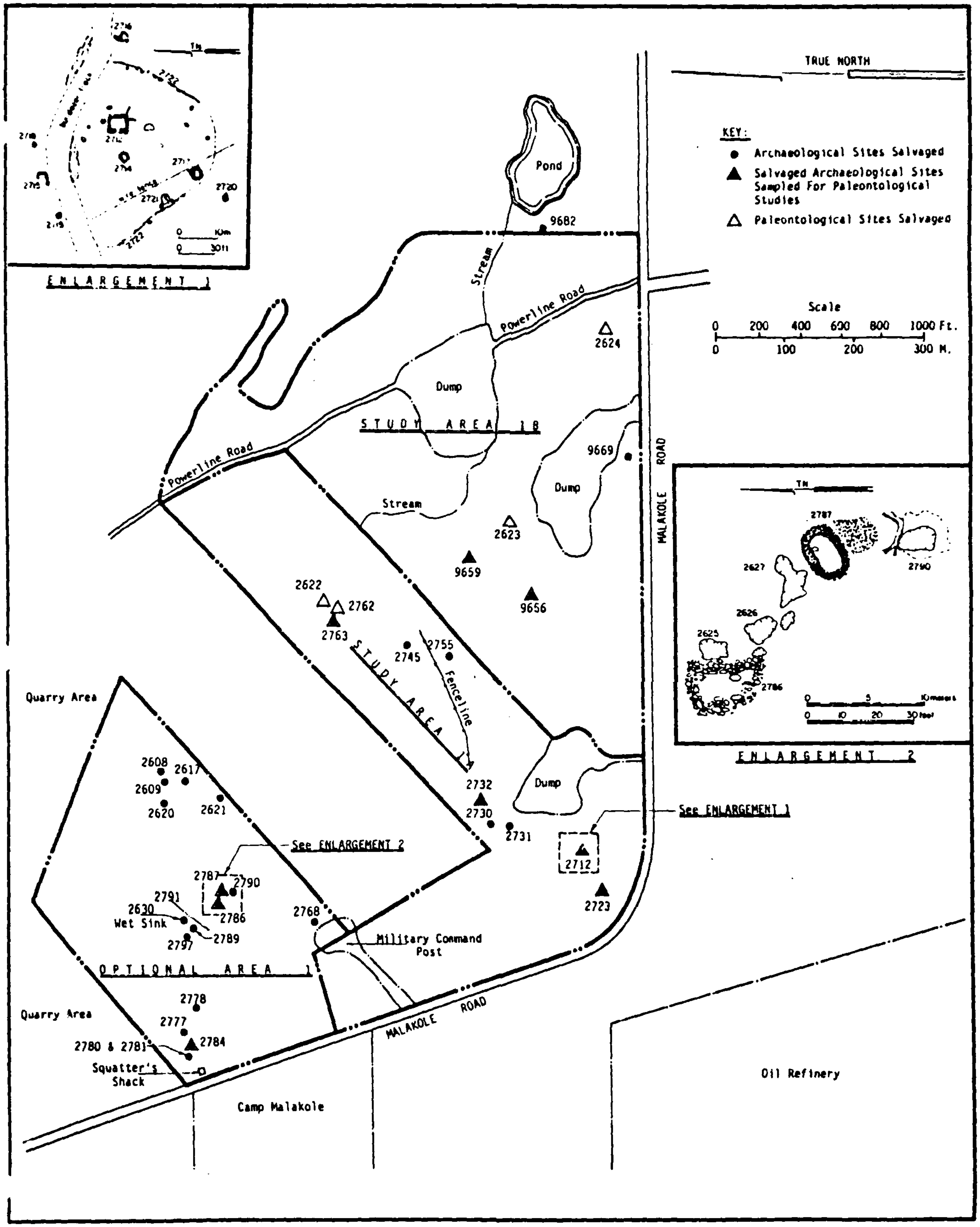

FIGURE 3 ARCHAEOLOGICAL SITE LOCATION MAP OF STUDY AREAS 1A, 1B AND OPTIONAL AREA 1, SHOWING ARCHAEOLOGICAL AND PALEONTOLOGICAL SITES SALVAGED

SCOPE OF WORK AND SUMMARY OF RESULTS

The overall objectives of work under this contract (Hammatt 1979) are to mitigate adverse effects of construction of the Barber's Point Deep Draft Harbor upon cultural resources in the Barber's Point Harbor Archaeological District. Based on a submitted and reviewed research design, and subject to coordination with the State Historic Preservation Officer, the Advisory Council on Historic Preservation, and the Keeper of the National Register of Historic Places, the contractor has recovered and preserved a sample of paleontological, scientific, prehistorical and historical archaeological data for analysis and interpretation of the cultural and environmental conditions prevailing during the period of human occupation.

Considering the scope of work and what was initially known of the nature of the sites, the following research objectives were defined:

1. Development of a firm stratigraphy and chronology for the sites and features of the study areas, including estimates of the span of occupation of individual sites from the earliest to the most recent period. Such a chronology would form the basic framework for investigation of spacial/temporal shifts in occupation, subsistence, construction style and site functions. The main emphasis would be on basaltic glass hydration rind measurements supplemented by Carbon 14 dates.

2. Definition of site/feature functions, particularly specific functions of habitation features in order to formulate propositions regarding the nature of residential units and their relationships to architectural variables.

3. Definition of the subsistence and manufacturing activities and the nature of specific activity areas within habitation sites and their internal relationships.

4. Determination of the nature and extent of environmental change for the purpose of establishing human paleoecological relationships with specific focus on agricultural potential, vegetation reconstruction and human/avifaunal relationships. This would be accomplished with analysis of natural stratigraphy, sedimentary and pedological patterns, as well as snail and avifaunal assemblages.

5. Documentation of the history of Hawaiian and Western occupation and land use at Barber's Point from European contact to the present. This documentation can have input into archaeological research in terms of ellucidating the nature and extent of modern modification of prehistoric remains, as well as functions and ages of historic structures.

The following documents were used to perform the archaeological field work and to prepare the reports in compliance with federal laws and regulations:

1. U.S. Army Corps of Engineers, Engineering Regulation (ER) 1105-2-460. "Identification and Administration of Cultural Resources," (33 CFR 305), April 3, 1978.

2. Advisory Council on Historic Preservation. "Protection of Historic and Cutural Properties," (draft) (36 CFR 800) 43 Federal Register 50651, October 30, 1978, especially, Supplementary Guidelines III.

3. U.S. Department of the Interior, National Park Service. "Recovery of Scientific, Prehistoric, Historic, and Archaeological Data: Methods, Standards, and Reporting Requirements," (draft) (36 CFR 66) 42 Federal Register 5374, January 28, 1977.

GENERAL SCOPE OF THE STUDY

Research Design

The research design was prepared by the supervisory archaeologist (Principal Investigator) and was reviewed by the Contracting Officer, the State of Hawaii Historic Preservation Officer and the U.S. Advisory Council on Historic Preservation. It included a statement of the research problems and an analysis of previous research; a statement of research questions and research objectives; and a list of testable hypotheses. Also included was a statement of data requirements; a sampling strategy to collect data to test the hypotheses; a listing of proposed field, analytic and data preservation techniques; and a tentative work schedule. It was agreed that the overall objective of the data recovery study complied with federal law and regulation (as listed) and that the research design provided for recovery of an adequate and usable sample of data on the significant research topics addressed.

It is necessary to point out that the research design was conceived as a starting point for a framwork to implement the research. It is not a formula or recipe to be applied to the final interpretations of the data recovered. The research goals have remained basically the same throughout the study but the applicability of the hypotheses have changed with the progress of the work and the feasibility of testing them. The degree to which the original research goals have been met does not provide a basis for evaluating the effectiveness of the research but is a statement on the amount and kind of data found in the sites.

Five research problems were defined in the research design:

1. The relationship between Hawaiian occupation and the Barber's Point ecosystem.

2. The history of Hawaiian occupation at Barber's Point.

3. Barber's Point settlement patterns.

4. The relationship between *previously unknown and extinct* endemic avifauna and the indigenous human population.

5. The Barber's Point cultural pattern as a unique adaptation to a unique environment.

The following hypotheses were formulated to address these research problems:

1. Hawaiian occupation of the Barber's Point area occurred late in the pre-European contact period.

2. The spacial/temporal pattern in occupation is represented by initial occupation of the smaller, more isolated residence sites, followed by a shift to the larger, more tightly clustered residence complexes, and then a reversal of the trend in the post-European contact period.

3. In the prehistoric period, intensity of occupation as well as specialization of function of certain features are related to the size of the features and size and density of the feature clusterings.

4. The larger residence units show greater specialization of function of each feature within the unit and greater intensity of occupation than the smaller units.

5. There is differentiation of site/feature function with all occupation features showing evidence of food preparation and consumption but only features within larger site clusters showing evidence of manufacturing activities.

6. Specific food preparation and cooking activity areas can be

discerned in the archaeological record and the dominant subsistence indicated by these areas is based on marine resources, and increasingly on terrestrial resources over time.

7. Manufacturing activity areas consisting of working of stone, bone, and shell materials can be defined in the archaeological record and occur in association with the food preparation and cooking areas. Manufacturing activities emphasize marine resources with terrestrial resources increasing over time.

8. If environmental change is demonstrated during human occupation of the Barber's Point area, the major cause will be human interference in the faunal and floral assemblages through the introduction and propagation of food cultigens and hunting of endemic fauna to extinction.

9. The historic period shows gradual complete abandonment of the area by native Hawaiians, followed by a dramatic change in land use with little or no cultural transition indicated.

Archaeological Data Recovery

The specific tasks to be accomplished were as follows:

1. Limited clearing and mapping as required to relocate known and previously located sites covered by vegetation since the sites were last surveyed.

2. Archaeological data collection by recovery of surface materials, test excavations or other means of testing, and salvage excavations.

3. The testing of a sample of modified and unmodified sinkholes in the study areas, sufficient to test hypotheses relating to the possible relationship between previously unknown and extinct

endemic avifauna and Hawaiian occupation. It was anticipated that most fossil avifauna samples would be initially preserved, identified, and sorted in Hawaii, and thereafter, sent to the Smithsonian Institution in Washington D.C. for further identification and analysis.

The following steps were followed to achieve these goals:

1. Test Excavations of all suspected habitation features were conducted to determine the presence of stratified evidence of human occupation, as well as evidence of distinct activity areas. This testing included location, collection, recording of vertical and horizontal provenience, and stratigraphic and feature association of all portable artifacts. Shell and bone midden and other residue were screened from the matrix through 1/8 inch and 1/4 inch screens with a 100% sample collected from the 1/4-inch screen. Basaltic glass was collected from the 1/8 inch and 1/4 inch screen. Stratigraphic profiles were analyzed and drawn.

   These test excavations made possible the evaluation of artifact content and density, midden composition and density, depth and lateral extent of cultural deposits, and potential subsistence and manufacturing activities and activity areas within and around features. A sample of modified and unmodified sinkholes was selected for testing on the basis of proximity to habitation clusters and special characteristics which showed potential for containing cultural material. The purpose was to determine the most promising "type localities" for horticultural features, fossil avifaunal excavation, natural stratigraphic analysis and landsnail collection.

   The testing phase was exploratory and, based on the results, it was possible to grasp the major elements of the research universe as well as the research potential of individual features. This was an essential first step since it insured the most effective and economical use of time and manpower at localities which presented the greatest probability for yielding significant results appropriate to the research goals.

2. Archaeological Excavations were conducted at sites which, according to the results of the test excavations, would potentially yield significant research information. Field procedures included recording vertical and horizontal provenience, and stratigraphic and feature association of all portable and nonportable artifacts. Shell, bone, and other residue were screened from the matrix through 1/4 inch and 1/8 inch screens with a 100% sample collected from the 1/4-inch screen. Basaltic glass and other artifactual material was collected from the 1/4 inch and 1/8 inch screens and was cataloged. Stratigraphic profiles were drawn.

The preliminary evaluation of artifact and midden assemblages and densities found during the testing focused attention to sites with defined manufacturing and subsistence activity areas. It was anticipated, on the basis of past excavation at Barber's Point, that these activity areas would consist of basalt, bone and basaltic glass workshop areas, as well as food consumption and cooking areas. Considering the effects of various types of sampling strategies on the types or intensities of field and laboratory analytical techniques, the emphasis was placed on establishing inter- and intra-feature chronology and on defining distinct activity areas to the maximum extent of their horizontal spread. Laboratory analysis involved compiling of density distribution of artifact types complimented with midden densities per excavated units. Every effort was made to develop a diachronic sequence for settlement patterns, subsistence and manufacturing activities, and construction.

The excavation phase also involved a detailed study of avifaunal "type" localities. These were sinkholes selected by size, geologic age and the nature and continuity of their depositional history.

Two (2) avifaunal type localities were selected. One is isolated from archaeological modification and the other directly associated with archaeological occupation. If other variables are taken into account, quantitative comparison of assemblages, as well as stratigraphic provenience would form a legitimate basis for evaluating human avifaunal relationships.

Six (6) sets of column samples for land snail analysis were to be collected from selected type localities. These sample localities were chosen with the consultation of Dr. Patrick Vinton Kirch and the samples were processed and analyzed by the Bishop Museum.

During the excavation phase, a selected sample of sinkholes was examined for sedimentary and pedological patterns to investigate the existence and extent of past agricultural activity. Modified and unmodified sinkholes of various sizes and depth both associated with and isolated from archaeological features were profiled. Information collected included the extent of development, depth, and characterization of soil horizons, as well as composition and other characteristics of sedimentary units. Column samples were collected from six (6) sinks for future pollen and land snail analysis.

Historical Data Recovery

Limited recovery and collection of historic data was authorized to the extent necessary to document both the history of military occupation and land use at Barber's Point and the relationship of this historic occupation and land use to changes in the study area's environment. An analysis of modern history since 1940, especially the era of U.S. Army use of Camp Malakole (Hono'uli'uil Military Reservation) has shed light on the function of some of the stone structures and other historic midden now found in the present study areas. A collection of oral accounts from persons who were stationed at Camp Malakole or who worked in the study area aided in this documentation.

Data Analysis and Reporting

Laboratory analysis of all excavated materials included these tasks:

1. Preparation of a master catalog of all portable artifacts recovered during testing and excavation. This catalog includes the description, vertical and horizontal provenience and strata associations of each specimen in the assemblage.

2. Artifact classification according to a number of appropriate criteria such as material, function, and age, depending on the research questions applied to particular assemblages.

3. Artifact density, provenience, and association analysis to define and document site and feature functions, manufacturing processes and activity areas, as well as variability through time.

4. Processing and analysis of basaltic glass for hydration rind measurements supplemented by Carbon 14 dating of charcoal samples.

5. Food residue (midden) analysis, including sorting of components, species identification and weighing. The midden collected was analyzed to document spacial and temporal patterns of residue disposal and subsistence activities.

6. Landsnail identification and analysis performed by Dr. Patrick Kirch of the Bishop Museum under a consultant arrangement.

7. Analysis of avifaunal remains performed by Dr. Storrs Olson of the Smithsonian Institution under a consultant arrangement.

8. Historic research including manuscript, photo, and map

searches and oral history collection focused on military land use and documentation of Camp Malakole and its residents.

Brief monthly summary reports of field and laboratory work performed during the previous month were submitted to the Corps of Engineers. The work summaries documented the percentage of work completed by each major work task and the subtasks. An interim report summarizing findings was submitted in the early part of data analysis.

SUMMARY OF RESULTS

Salvage excavations in Study Areas 1a and 1b and Optional Area 1 of the Barber's Point Deep Draft Harbor project produced a significant body of data with which to interpret the nature and extent of human occupation on the coral plains of 'Ewa. The original research objectives have for the most part been attained although some interpretations were not anticipated and some hypotheses were not tested because of insufficient or ambiguous data.

The degrees of success in meeting each objective addressed are summarized below in order of presentation in the general scope of the study:

1. Development of a firm stratigraphy and chronology for the sites and features of the study areas.

In a broad sense, it was possible to associate specific cultural strata with specific time periods of human occupation by means of the artifact assemblage. That is, Stratum I (the recent A1 horizon) is present throughout the study areas and contains all but a few of the historic artifacts found during the study.

Stratum II (a buried cultural A horizon) is present in all of the surface habitation sites and is remarkably consistent between sites in relative position and content (traditional Hawaiian tools and fish and shellfish midden). Charcoal samples adequate for dating were recovered from Stratum II in Sites 2712, 2777, 2787 and 2790. Results of the radiocarbon dating analysis showed all of the samples to be "modern" (100 years old or less). Basaltic glass was recovered from Sites 2731, 9682, 2787, and 2789. However, only samples from 2731 and 9682 were datable.

This objective concerns the first two hypotheses listed in the General Scope of the Study. The first hypothesis--that Hawaiian occupation of the Barber's Point area occurs late in the pre-European contact period--is contradicted in part by the traditional forms of artifacts in the assemblage and the absence of historic materials; and secondarily by the assemblage of fishhooks, which indicates a relatively early age for the sites since the stylistically older head type HT1a predominates. It is important to note, however, that traditional Hawaiian tools were still in use as late as 1832 at Hanalei, Kaua'i (Hammatt and Folk 1979), and that the HT1a head type was still being manufactured as late as 1650 (Emory, Bonk, and Sinoto 1968) and probably was still made up to the time of replacement of the traditional forms by imported metal fishhooks. The basaltic glass analysis, although it resulted in dating of only two (2) sites, does not support this hypothesis that Barber's Point occupation occurs late in the pre-contact period. The hydration rind measurements on glass from Site 9682 range from 550 ± 75 to 1760 ± 21 basaltic glass years A.D. with one date of 1080 ± 96 for Site 2731. These dates argue that the Hawaiians found and used the raised coral plain at Kalaeloa at an early stage after their arrival to the Islands and that it was used since that time.

The second hypothesis--that the spacial/temporal pattern in occupation is represented by initial occupation of the smaller, more isolated residence sites, followed by a shift to the larger, more tightly clustered residence complexes, is considered a reasonable interpretation (see page 19) but lacks a supportive quantitative chronology.

2. Definition of site/feature functions, particularly specific functions of habitation features in order to formulate propositions regarding the nature of residential units and their relationships to archaeological variables.

This objective addresses our third and fourth hypotheses. These hypotheses are: In the prehistoric period intensity of occupation, as well as specialization of function of certain features are related to the size of the features and size and density of the feature clustering; and that the larger residence units will show greater specialization of function of each feature within the unit and greater intensity of occupation than the smaller units. Testing these hypotheses met with limited success. The intensity of occupation of any particular site in the study areas is difficult to assess because of the lack of datable material. Nevertheless, if it is assumed that all the sites were occupied for a uniformaly brief time for each separate phase of occuaption. (Site 9682 may be an exception) then a greater intensity of occupational activity at some of the larger habitation sites (2712, 2777, 2787) is demonstrable.

It was possible to define general functions in all of the habitation sites (except at Sites 2768, 2786 and 2617). Differences in type of occupation and use are indicated among sites and range from temporary shelters to mens' houses and small kauhale (see below). The differences in site design and size that do exist are more likely the result of functional variation rather than status differences. Sites of similar function are fairly uniform in their attributes.

3. Definition of the subsistence and manufacturing activities and the nature of specific activity areas within habitation sites and their internal relationships. To define manufacturing activities occurring exclusively in habitation features by study of the patterned distribution of artifacts and midden around and in features, and by certain architectural attributes.

This objective addresses the fifth, sixth, and seventh hypotheses. The fifth hypothesis--that there is differentiation of site/function with all occupation features showing evidence of food preparation and consumption, but only features within larger site clusters showing evidence of manufacturing activities--is not demonstrated. That is, all of the habitation sites in the study areas (with the exception of 9669, 2732, 2745, 2768, and 2617) contained evidence of manufacturing activities, as well as evidence of food preparation and consumption regardless of site location, size, or proximity to other habitation sites.

The sixth hypothesis--that specific food preparation and cooking activity areas can be discerned in the archaeological record and that the dominant subsistence indicated by these areas is based on marine resources with increased emphasis on terrestrial resources through time--was born out in part. Specific food preparation areas are not clearly defined in the archaeological record, but cooking hearths are dominant features in each of the habitation sites except 2732, 2763, 9669, 9682, 2768, and 2617. The primary subsistence resources evidenced in the archaeological data are derived from the maritime ecosystem. Evidence of terrestrial subsistence resource exploitation is restricted to the presence of mammal (pig and dog) bone, bird bone, egg shell and kukui nut shells. Data is insufficient to show that terrestrial resource exploitation received greater or less emphasis through time, but avifauna probably was heavily exploited initially then replaced by pig and dog as the local bird populations (identified in all sites as Pterodroma phaeopygia or dark-rumped petrel) were disseminated or displaced by intensive exploitation. Archaeological evidence of any horticultural produce present in the habitation sites has been reduced beyond recognition by the elements. Faunal material is restricted to a few kukui nut (Aleurites moluccana) shells not sufficient to determine changes in exploitive emphasis.

The seventh hypothesis is that areas of manufacturing activities related to working with stone, bone, and shell materials can be defined in the archaeological record and occur in association with the food preparation and cooking areas; and also that manufacturing activities show emphasis on marine subsistence with increased emphasis on terrestrial resources through time. This hypothesis proved workable for the most part. Manufacturing areas are definable in all of the habitation sites except 2732, 2745, 2768, 2778, and 2617. However, stone-working activity is evidenced only in Sites 2712, 2730, 9682, 2787, and 2789. Although in most habitation sites the manufacturing areas occur in association with cooking areas as hypothesized, Sites 2724 and 2777 appear to have had two (2) separate function-specific areas: one for manufacturing and the other possibly for cooking. Archaeological evidence expressing a change in emphasis from marine resources to terrestrial resources by midden changes through time is difficult because of thinness of deposits and stratigraphic mixing. Because a firm chronology for each site is lacking, inter-site analysis of shellfish tools to mammal bone tools cannot provide adequate evidence for temporal change in exploitation emphasis.

4. Determination of the nature and extent of environmental change for the purpose of establishing human paleoecological relationships with specific focus on agricultural potential, vegetation reconstruction and human/avifaunal relationships (see Appendix I and II).

The hypothesis formulated to address this subject was, if environmental change is demonstrated during human occupation of the Barber's Point area, the major cause will be human interference in the faunal and floral assemblages through the introduction and propagation of food cultigens and the hunting of endemic fauna to extinction.

The landsnail succession shows major change in proportions of species through time. This successon is useful to some extent in reconstructing vegetation changes. The extinction of native shell and many bird species, particularly forest birds, is almost certainly related to habitat destruction caused by direct or indirect human interference. However, natural mixing of deposits as well as absence of chronometric dates leave the phases and chronology of avifaunal extinction unclear at the present time.

The snail shell analysis of a small shallow sink showed unexpected numbers of freshwater species (Assiminea) and sheds light on probable agricultural practices within the sinks. Apparently the sink was mulched with organic sediments carried from a nearby marshy pond to increase productivity of the sink. This might have been a general agricultural pattern throughout the area.

5. Documentation of the history of Hawaiian and western occupation and land use in the study areas at Barber's Point from European contact to the present.

It was possible to document aspects of the history of Hawaiian occupation at Barber's Point to the degree defined in the first four general objectives of the study. It was also possible to document military occupation and land use in the study areas at Barber's Point beginning in 1940. Before the military era, much of the study area was utilized for cattle grazing. Both of these activities constitute the dramatic change in land use from traditional Hawaiian practices to Western occupation. No archaeologically expressed evidence of cultural transition is present in the excavations nor is there conclusive evidence to show that gradual complete abandonment of the area by native Hawaiians preceded the change in land use.

Archaeological data, including analysis of artifacts, midden, and features for each stratum and site as well as stratigraphy, basaltic glass and charcoal dating, and site architecture, show that Stratum II is similar to other typical prehistoric (?) occupation areas. That is Stratum II is complete with bone and shell fishhooks, basaltic glass, adz flakes and shell and bone midden. The traditional Hawaiian technology and adaptive strategy encompassed all the knowledge necessary to cope with the unique topography and relatively low productivity potential of the study area.

Some of the initial hypotheses concerning the archaeology at Kalaeloa turned out to be untestable, given the data available from the excavations and some were inappropriate in the context of making meaningful generalizations about settlement and were formulated as guidelines on the basis of previous surveys and expectations for the excavation phase.

The degree to which the hypotheses were testable or appropriate was determined largely by the limitations and potential of the sites themselves and the cultural layer within them. For example, it was soon demonstrated in the stratigraphy (shallow, mixed deposits) that study of an individual site through time was not possible. Therefore, the smallest unit of study was the site itself and not individual stratigraphic components within sites except in a very broad sense such as to define historic verses prehistoric occupations.

Evaluation of the data during field work and laboratory analysis was an integral part of the process for refining and reformulating the hypotheses, as well as emphasizing those that were not appropriate. It became apparent from the limited quantitative chronology available from this project and analysis of intersite variability, that shows a very high number of habitation sites to have the same apparent function, that we were looking at a diachronic instead of a synchronic development. Only in two (2) instances are there differences in residue disposal patterns that indicate complimentary or dependent functional relationships. Inter-site variability documented in the distribution patterns of artifacts and midden became one of the prime sources of data for the diachronic development of human settlement as expressed in inter-site variability. This confirms the importance of inductive, as well as deductive processes in the formulation of archaeological interpretations.

The sites are grouped empirically according to the following criteria:

1) The location of hearths interior and/or exterior within a site.

2) The distribution of artifacts (manufacturing areas) in the interior and/or exterior.

3) The distribution of midden (food comsumption) in the interior and/or exterior.

4) Inter-site variability in artifact assemblages. Because of the small number of artifacts, we are dealing with presence or absence.

5) Inter-site variability in midden density. Because of the small quantities of some components of the midden, presence and absence was used as criteria.

Because of the many different criteria used and the simple non-quantifiable nature of the criteria, these groups can not be documented and arrived at statistically. The grouping is developmental in that there is an assumed increase in permanency in habitation through time.

Habitation sites in the study areas can be grouped into shelters, nuclear sized family dwellings and kauhale based on inter-site comparison of intra-site disposal patterns and feature associations (refer to Density Maps for each site). These site types and the criteria for definition are discussed here in a postulated relative chronological sequence of occupation from early pioneering and settlement to more permanent residence.

Shelters in the study areas (Figure 3) consist of three (3) unmodified sink-holes (Sites 2763, 9669 and 2790), and five (5) surface structures including an L-shape (2723), a C-shape (2731), two (2) U-shapes (2732 and 2778) and a hearth (2745). The surface shelters contain low densities of midden and artifacts associated with a small, poorly defined hearth deposit in the site interior. These characteristics suggest short term occupancy in lean-to type houses where sleeping, eating and limited manufacturing was done, probably by single individuals. Site 2731 contains a high frequency of shell fishhooks and coral tools, and hematite and basaltic glass which does not conform with the criteria, however, all these materials were found in the enclosure interior. The three (3) sink shelters differ somewhat from each other and the surface shelters, but most of the criteria for defining a shelter are present. All archaeological materials are confined to the sediments in the sinks. Site 9669 has low densities of midden and artifacts indicating food consumption and brief occupation. No hearth was found and no clear evidence of manufacturing activities are present. Site 2790 contains a hearth and some bird bone midden in its earliest cultural level with no evidence of manufacturing suggesting brief occupation and individual procurement of subsistence foods. This early level in 2790 is overlain by a later cultural level displaying very different characteristics (discussed later). Site 2763 is probably an early occupation site in the study areas and contains large quantities of bird bone midden with some shellfish and fishbone. Artifact frequency is low but the artifact types suggest limited manufacturing of fishing related tools.

Nuclear sized family dwellings are single rectangular structures of small to medium size with formal entrances. Site 2730, 9682, 2777 and 2789 are included in this classification based on intersite comparison of artifact and midden disposal patterns. The similarities are: lower artifact frequency and midden density inside the enclosures; high frequency of artifacts and high density of midden at the entrances and immediately outside the entrances; formal interior hearths with primarily midden associated indicating predominantly food consumption; secondary external hearth or ash deposits having fishing related artifacts indicative of manufacturing activity associated. The quantities of cultural material and the thicker and more continuous cultural layers in these sites suggest more intensive occupation while the distinctive disposal patterns and specialized activity areas suggest more permanent and protective pole and thatch _hale_ than are indicated for shelter sites. The nature of these more permanent and specialized _hale_ restricted the natural light in the interior of the sites, thus directing day time activities and consequent detritus and midden disposal patterns to the doorway or outdoors.

Site 9682 deviates from the norm in that no hearths were found in the excavations, however, peak concentrations of midden, as well as peak concentrations of artifacts are outside the site. The poor state of preservation of this site precluded conclusive identification of the former entranceway.

Two (2) _kauhale_, the traditional Hawaiian multi-structure home, can be tentatively identified in the study areas (see Figure 3). These center on Sites 2712 and 2787.

Site 2712 and 2787 are tentatively identified as hale mua or mens' houses. This determination is based on the large size of the structures, the presence of distinct entranceways in a four-sided rectangular enclosure, the presence of large interior hearths with peak concentrations of artifacts and midden present around the hearth, in the entranceway and immediately outside the entrance. The frequency of artifacts associated with manufacturing fishing gear is high as is the density of midden. The stratigraphic cultural layer is considerably thicker in these sites than in the shelters and nuclear family dwellings in the study area. Associated structures comprising the kauhale are, in the case of 2712, a wet sink, sinks suitable in diameter and depth for agriculture, very small enclosures (probably for storage), ahu and a low wall encompassing the whole of these structures (Sites 2714 through 2721). In the case of 2787, subsidiary structures include a probable sleeping hale (2786), an early sink shelter subsequently used as a refuse pit (2790), a wet sink (2630) and at least three (3) agricultural sinks (2625, 2626 and 2627).

The criteria used (above) to classify the habitation sites in the study area as shelters, nuclear family sized dwellings, hale mua and kauhale may or may not be applicable to archaeological sites in other areas of the Hawaiian Islands, nevertheless it allows for some general statements about settlement patterns and social structure on the marginally productive (excluding fishing and bird hunting) coraline 'Ewa plain. The majority of habitation sites present in the study area are small shelters and small nuclear family sized dwellings. The early Hawaiians were probably attracted to the area initially because of the availability and relative ease of obtaining food resources (including birds, bird eggs, marine molluscs and fish). More permanent residence traits (an increase in the manufacture of fishing gear and the use of domestic pigs and dogs for food) reflected in the larger sites, some of the nuclear family sized sites and the advent of horticulture in suitable sinks, are probably the result of a more lengthy history of temporary seasonal occupation. It is in these larger sites and complexes that evidence of the use of adzes and an increase in the importation of basalt objects and forest resources (i.e., kukui nut) are found.

The establishment of permanent residence may have occurred far later, if at all compared to the more agriculturally productive areas of Honouliuli or O'ahu as a whole. The low agricultural productivity and seasonal occupation in this limestone region of the ahupua'a probably curtailed full expression of Hawaiian social structure and status distinctions. However, because of the easily available avifauna and, marine resources and the promimity to Pu'uloa this may have been one of the prime areas on O'ahu to be exploited by small groups during initial settlement. There is no archaeological indication of high status residence in the study areas but this may be due to the temporary nature of the occupation. Indication of low status rank could be inferred by the burial practices evidenced in the two (2) burial sinks (2620 and 2621) if we use the single criteria of intensity of labor presented by Tainter and Cordy (1977), however, inferred status based on this single criteria is dubious because it is only one aspect of the life of the individuals interred.

Interpretations relating to spacial and synchronic relationships are severely limited by the lack of archaeological evidence for inter-site contemporaneity and by the amount of modern disturbance in the study area. The lengthly sequence of about 1,200 basaltic glass years shown at Site 9682 may reflect the relatively large time span in which the study area was occupied. Inter-site variability is seen as a diachronic sequence of intermittent occupation by single individuals and nuclear families.

The suggestion that Kalaeloa contained an integrated community which presumably developed from demographic pressure in neighboring areas is not substantiated archaeologically except in the two (2) possible cases of Site 2712 and 2787. These are the only sites which, as focal points of small complexes, reflect any degree of imposed social contraints characterizing traditional Hawaiian social organization.

The interpretations are summarized as follows:

1) The extinction of over 30 species of Barber's Point avifauna occurred late in geologic time and at or near the time of human occupation. The extinction probably resulted from habitat destruction caused by direct or indirect interference of humans (see Appendix I and II).

2) It is possible that the indirect effects preceeded the actual human occupation. There is evidence of direct exploitation of dark rumped petrel (Pterodroma phaeopygia) and collection of bird eggs (species unknown). This probably occurred early in the habitation sequence.

3) Permanent occupation occurred late in the history of settlement of the islands although there is evidence from one site that the area was one of the first to be exploited by early Hawaiians on O'ahu. Inter-site variability is seen as the result of temporal developments and changing subsistence and not as contemporaneous communities.

4) The inhabitants lived in small shelters and enclosures, which show a distinct pattern of activity areas and refuse disposal. The site interiors, generally containing a hearth, are sparse in evidence of manufacturing and tool use but do contain some food residue. They served as sleeping hale(s) for nuclear family sized groups. The activity areas are generally at the site exteriors near the entrances where the bulk of the tool use and manufacturing took place in conjunction with food consumption.

5) Subsistence of the occupants emphasized collection of shellfish and fish with very limited consumption of dog and pig. Food crops were grown in sinks whose productivity was possibly enhanced with the addition of muck from nearby marsh deposits (see Appendix II).

6) Site size and complexity increased through time with sites being improved and made more comfortable with successive occupations. This progressive enhancement (complexity) of occupation implies an increasing efficency of lifestyle rather than additive structural changes in society and provides a feasible explanation for the nature of the sites and inter site variability.

7) The human population was probably controlled by the seasonal fluctuation in supply of marine resources, the seasonal cycle of planting in other areas of the ahupua'a, and perhaps initially by the availability of seabirds. Even though the population was small, and probably mobile at least in the earlier phases, the traditional Hawaiian technology and adaptive strategy provided all the knowledge necessary to cope with the unique topography and relatively low agricultural productivity of the study area (compared to valley floors and alluvial plains). Without a doubt, this limestone region was incorporated in the inventory of available resources of Honouliuli ahupua'a and probably was part of the overall resource base during the early exploration phase on O'ahu as well.

RECOMMENDATIONS

All the archaeological remains in the study areas were located and described. All habitation features from the study areas, as well as a sample of nonhabitation features were tested (selected on the basis of proximity to habitation clusters and of their potential for containing cultural material). During the excavation phase, a selected sample of sinkholes was examined for sedimentary and pedological patterns to clarify the existence and extent of past agricultural activity. In addition, other column samples were collected for further analysis. Those sites found to have excavation potential based on testing results were excavated. As a result, appropriate archaeological information concerning the nature and time depth of human occupation has been salvaged.

The archaeological research conducted indicates a fairly low occupation density at any given time and a fairly low percentage of land utilization. The posited agricultural features (sinkholes) are the result of geologic phenomena and were probably improved and utilized by the occupants for production of staple foods and other domestically important plant products, especially those species (ki, noni, wiliwili, naio, ipu, and possibly u'ala) that could maintain themselves without cultivation during periods of human absence.

The number of traditional habitation sites situated on the coraline 'Ewa plain and the degree of their preservation distinguish this project area from others. It is the presence of these features and the unique land form that makes the area archaeologically interesting and that promoted some archaeologists to support inclusion of these sites on the National Register of Historic Places. However, detailed evaluation of the sites in the study area during the salvage excavations has shown that they are fairly typical (Site 2763 is an exception) of small, seasonal occupation sites of coastal areas where marine resources abound throughout the main Hawaiian Islands. This Hawaiian tradition of seasonal migration of people from their permanent habitations to the beaches where temporary camps are established for extended periods of two to three months duration continue today. Regulation of the duration of this [illegible] by the present state government has resulted [illegible] frontation and protest by [illegible] Hawaiians following this practice. Based on the evaluation of the [illegible], further excavations would produce minimal results which [illegible] only emphasize the patterns already defined. None of the habitation [illegible] miscellaneous features such as ahu or agricultural [illegible] are appropriate for preservation either from [illegible] viewpoint since their architectural and other physical [illegible] not unique or impressive. In addition, they do not illustrate any particular theme in Hawaiian archaeology that cannot be better presented elsewhere. For these reasons and because their scientific potential has been addressed in the salvage excavations, complete archaeological clearance is recommended for the entire project area.

[illegible] addition to the archaeological excavations, a sample of modified [illegible] the most promising [illegible] for paleontological [illegible] found to contain fossil [illegible] 2624, was particularly rich in quantities [illegible] extinct endemic birds. The productive deposits within this sink were salvaged during the [illegible] logical excavation phase.

Many questions about the prehuman and prehistoric ecology [illegible] and its associated avifauna are still unanswered and could [illegible] further investigation. This work should be continued, either [illegible] present [illegible] or in surrounding areas logically by the [illegible] the intent and terms of [illegible] vation Act of 1966. The analysis of materials already collected should be completed before further field work. In addition quantitative dating of the fossil material should continue to clarify the contemporaneity [illegible] man introduced vertebrates (rats and lizards, [illegible] terrestrial [illegible] with the extinct bird spec[illegible].

PHYSICAL AND CULTURAL GEOGRAPHY

The study areas, designated Optional Area 1 and Study Areas 1a and 1b, are situated in the Campbell Estate lands at Honouliuli, 'Ewa, O'ahu. The coastal land from near Lualualei, Wai'anae, along the leeward coasts of Wai'anae and Ko'olau Volcanos, to Le'ahi (Diamond Head) and beyond, consists of an emerged calcareous algae and coral fringing reef. This reef, referred to as the Honolulu and 'Ewa plains, underlies recent deposits of alluvium and is interbedded with and overlain by lavas and cinder, spatter, and ash cones of the Honolulu Volcanic Series of Ko'olau Volcano and upper member lavas of Wai'anae volcano (Macdonald and Abbott 1970). At Honouliuli, the 'Ewa plain stretches 3 to 4 miles inland from the present shoreline. It is buried by alluvium along the landward side and a large percentage of it is under sugarcane cultivation. The study areas are located along the western seaward edge of the plain where the surface of the emerged reef is exposed (Figures 4 and 5). Prehistoric occupants lived on this surface and used the limestone reef rocks as building materials.

The irregular surface of this emerged reef is karstic--that is, it is a limestone region marked by sinks, abrupt ridges, irregular protuberant rocks, caverns, and underground streams. The depth of the sinks at Barber's Point range from a few centimeters to about 2 meters in the seaward parts of the study areas. Inland, where elevation increases, sink depths sometimes exceed 3 meters. These sinks vary greatly in diameter and shape, partly as a function of geomorphic age.

The archaeological sites are often situated over filled-in sinks. Other sites are positioned on nearly level bedrock surrounded by sinks. In some cases sinks have been used for occupation-related activities and in earlier times served as nesting places for birds.

Honouliuli is the largest and western most ahupua'a in the District of 'Ewa. The west boundary follows the ridge line from Palikea in the Wai'anae mountains reaching the sea at Piliokahe and was defined by the gods Kane and Kanaloa. The eastern boundary touches upon the inland

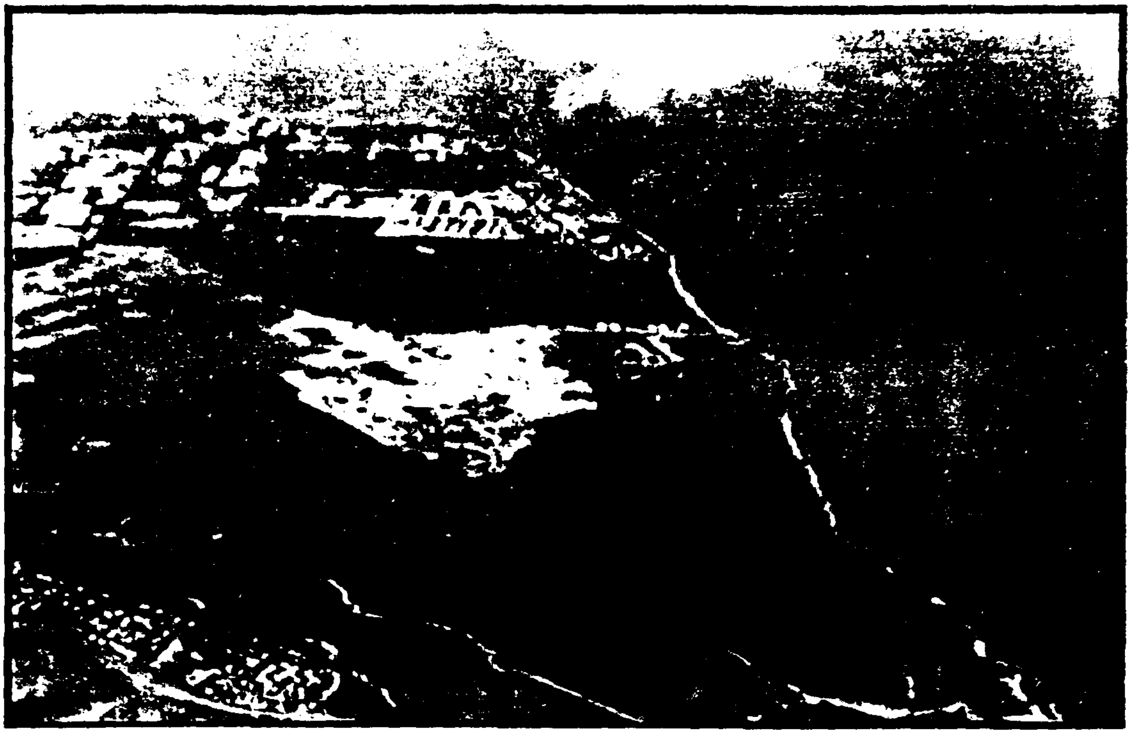

FIGURE 4   AERIAL VIEW OF THE COASTAL STRIP OF THE 'EWA PLAIN AT HONOULIULI, O'AHU

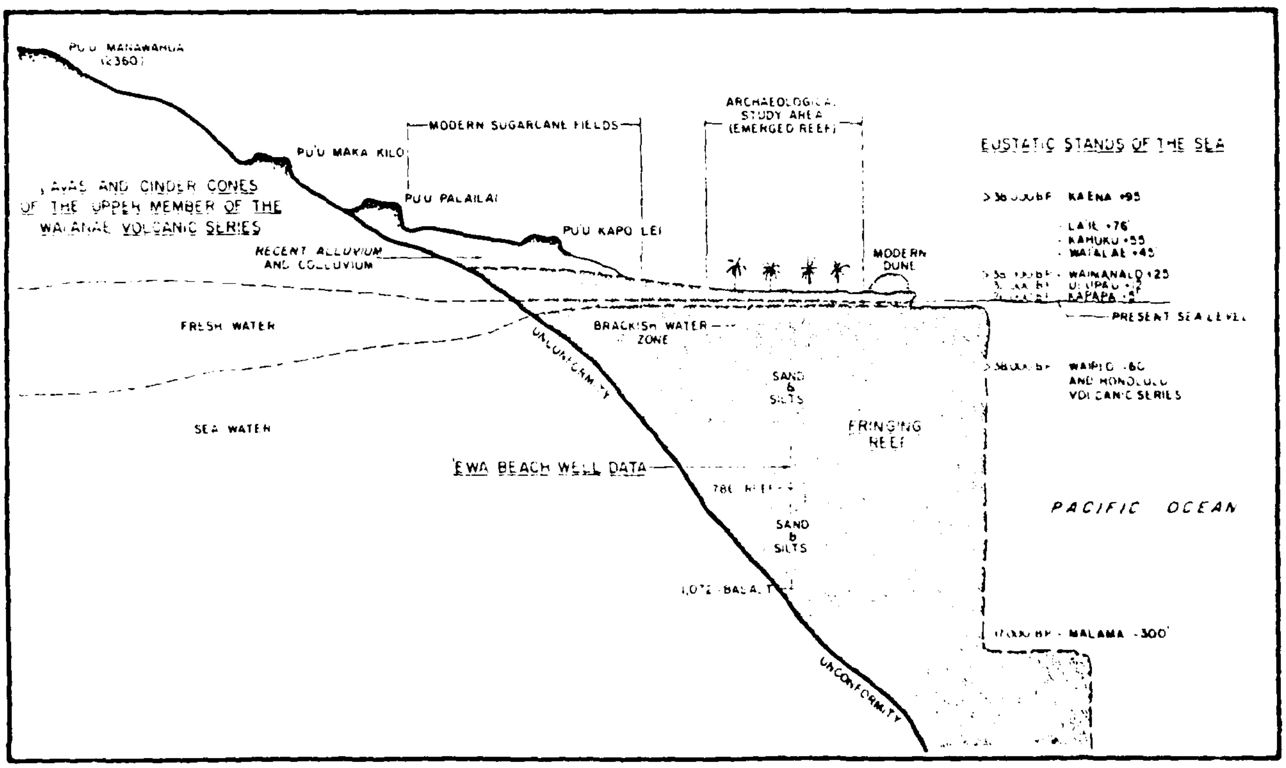

FIGURE 5   SCHEMATIC CROSS-SECTION OF GEOLOGIC LAND FORMS AROUND THE STUDY AREA (COMPILED FROM DATA IN MACDONALD AND ABBOTT 1970)

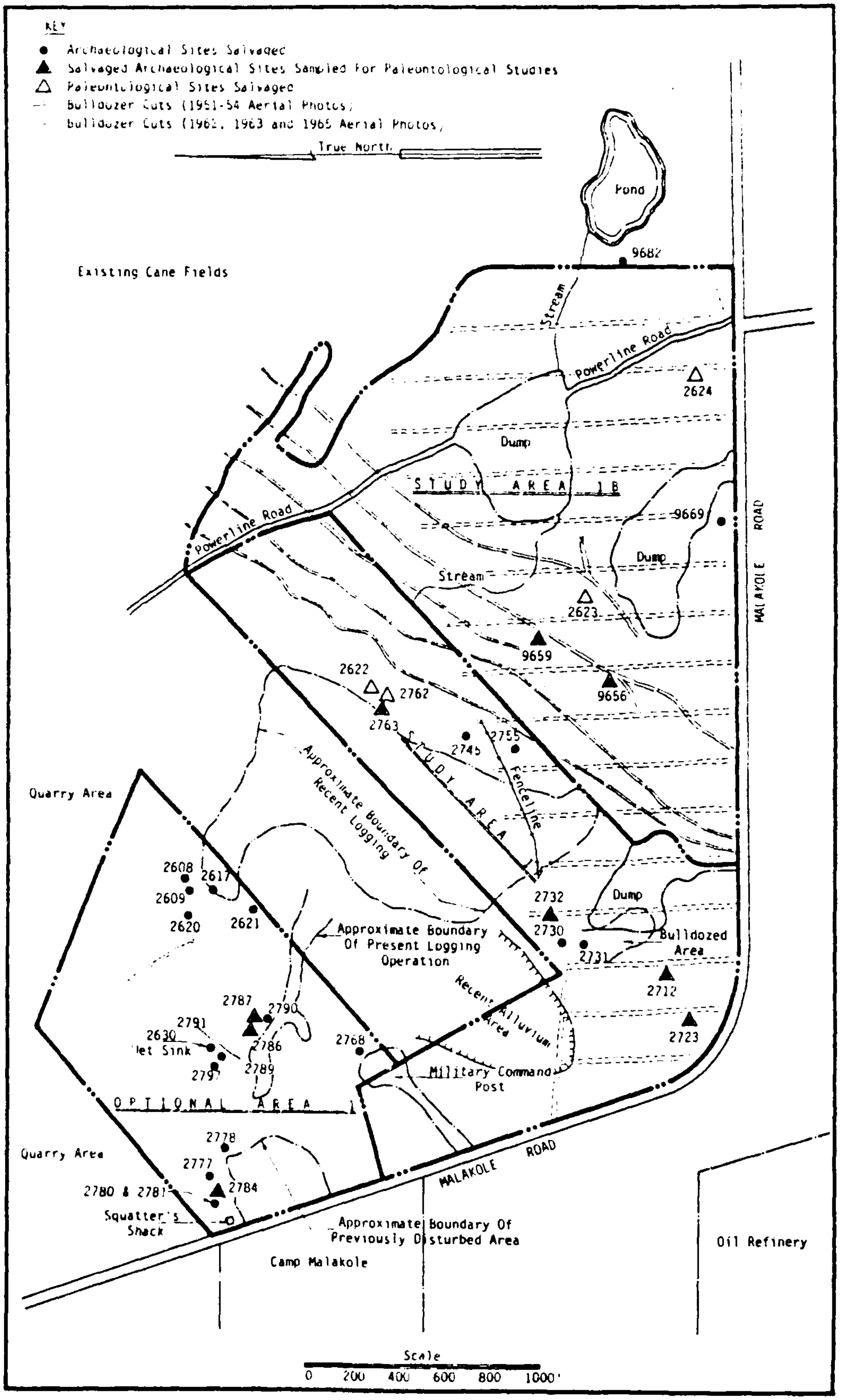

FIGURE 6 ARCHAEOLOGICAL SITE LOCATION MAP SHOWING EXTENT OF MODERN EFFECTS UPON THE LANDSCAPE

portion of Pu'u Loa near the <u>mauka</u> end of what is presently West Lock (Kaihuopala'ai), thereby, providing access to the resources which these waters contained. A number of fishponds are still in evidence here (refer to McAllister 1933: 108; Sites 140 and 141). At this point the boundary extends inland, east of Honouliuli Stream and intersects with the western boundary in the vicinity of Palikea. Honouliuli contains <u>uka</u>, <u>waena</u> and <u>kahakai</u> lands common to <u>ahupua'a</u>, providing its inhabitants with all of the necessary resources needed for full economic subsistence. It is in this frame that the archaeological sites in the study area must be viewed, and not in the limited space defined by the project boundaries.

Honouliuli(s) prominent geographical features (refer to Figures 2 and 3, Lewis 1970), notably Pu'u Kapolei and Pu'u Ku'ua are associated with Kapo a sister of Pele. Pu'u Kapolei <u>heiau</u>, on the hill of the same name, was recorded by McAllister (1933; Site 138) and figures in the legends of Kamapua'a, a demigod with legendary associations to the sweet potato ('uala) and other important domestic plants, the rain cycle and therefore, to Lono makua (Handy and Handy 1972 : 338). Although McAllister does not provide information on the type of heiau it was, we suggest that it could have been related to agriculture, based on its geographical position between the cultivated coral lands McAllister 1933: 109; Site 146), taro lands, forests and the association with Kamupua'a.

Limaloa, the name of a gulch situated near the western <u>ahupua'a</u> boundary was also the name of a lover of Kamupua'a further attesting to that gods' persuits in Honouliuli.

Pu'u Ku'ua <u>heiau</u> (Site 137), Palikea, was situated on the ridge overlooking both Nanakuli and Honouliuli. Pu'u Kuina <u>heiau</u> (Site 134), Aikukai, is said to have been located in the gulch at the foot of Mauna Kapu. Another <u>heiau</u> (Site 133) is said to be located in a gulch at the foot of Pu'u Kanehoa. No detailed information is given of these temples never-the-less, the number of <u>heiau</u> mentioned in Honouliuli is another indicator of the former importance of this land.

At Kapapapuhi, near the west end of West Loch (Kaihuopala'ai), is the fishing shrine (<u>ko'a</u>) Kalanamaihiki (Site 139) and not too far away is the fishpond Laulaunui. These sites and those mentioned attest to the political and religious aspects of Hawaiian society in this _ahupua'a_

Waimanalo gulch (near western boundary) literally translated as "potable water", was the home of the _ali'i_ Kākuhihewa (Pukui, _et al_ 1974). This chief was the _Ali'i Nui_ of O'ahu during the time of Keawe-nui-a-Umi on Hawai'i (Kamakau:1961).

Another gulch, Kalo'i near the middle of Honouliuli indicates that irrigated taro fields were once located here.

Kualaka'i is situated on the coast to the east of Kalaeloa. A spring called Hoakalei is located here and is associated in legend with Hi'iaka, the favoriate sister of the fire goddess Pele.

Two place names in Honouliuli suggest associations with fishing, Keoneoio [literally, "sandy (place with) bone fish" and Pu'u Lailai (literally, young _lai_ fish hill"] (Pukui, _et al_ 1974). The latter suggests an association with offshore fishing and could have been used as a range or bearing marker for fishing grounds. Pu'u Makakilo(s) literal translation (observing eyes) may also relate this landmark to fishing activites, _kilo_ is the Hawaiian word for fishing observation tower or place. Makaiwa (a gulch situated to the east of Waimanalo gulch) may also be related to fishing if the name is translated as the "eyes of the frigate bird". Pukui, _et al_ (1974) translates Makaiwa as "mother of pearl eyes" (as for _ki'i_ - image) suggesting an religious association.

The study and interpretation of the place names of Honouliuli could go on and on, however, the purpose of the above discussion is to point out that the archaeological remains in the study area cannot be considered a separate entity. The extensive coral lands of the study area were an important resource to the inhabitants of this land, the "marginal" and "desolate" labels associated with this area are clearly a Euro-American perspective unbefitting the importance of this region in the Hawaiian economic system. This is a good example of some of the misconceptions entertained by early Western observers concerning the importance of certain lands and in general Hawaiian land use patterns.

Modern cultural effects on the landscape within the study areas (Figure 6) include recent large-scale dumping at three localities (one in Study Area 1a and two in Study Area 1b) and dumping of domestic trash in sinks around a squatter's shack and a military compound in Optional Area 1. Aerial photographs taken in the 1950's, 1960s, and 1970s show a changing pattern of bulldozer cuts. Moreover, recent logging roads and logged areas were observed during the present field work, and evidence of previous logging over an even larger area was apparent in reforested areas.

The archaeological sites have suffered from these modern activities and undoubtedly some sites have been destroyed, especially in Areas 1a and 1b. Nevertheless, some archaeological sites seem to have been avoided deliberately especially by the loggers.

The extent of impact by the military presence in the study areas is known from two sources, ethnology and archaeology.

The impact of military operations in the study areas is primarily a result of training manuvers conducted for other installations on O'ahu rather than for personnel billeted at Camp Malakole (personal communication with Robert A. Albert; from informants providing information in A STUDY OF THE WARTIME HISTORY OF CAMP MALAKOLE - Appendix III, this report.) This impact cannot be accurately evaluated except for those sites with direct archaeological evidence of military use (Sites 2712 and probably 2746, 2790, and 2796).

There is also direct evidence for use of a portion of Optional Area 1 for dumping of trash from Camp Malakole. That is, a number of unmodified sinkholes in the area between Sites 2768, 2777 and 2796 contain modern trash, some of which bears the mark QMC (Quartermaster Corps) (Refer to figure 6). It is not known what other military activities took place but it is possible that the network of bulldozer roads concentrated in Study Areas 1a and 1b are also a result of these operations.

PREVIOUS RESEARCH

The writing of the prehistory of Honouliuli, 'Ewa, O'ahu began in the 1930s with a surface survey by J. Gilbert McAllister (1933). McAllister recorded specific locations of important sites, and the general locations of less important sites (at least in Honouliuli). He considered the sites in the present study area in the latter catagory.

During 1969-1979, a new phase of archaeological research initiated by the United States Army Corps of Engineers was carried out by Ernest Lewis (1970), William Barrera (1975), Aki Sinoto (1976, 1978, and 1979), and Bertell Davis (1978). In his report , Lewis included a summary of historical accounts and early maps of the region and a summary of significant aspects of the geography and geology of the study area. In his concise summary of McAllister's survey findings, Lewis noted Dr. Kenneth Emory's record of a house site and heiau in Honouliuli in 1933. Lewis also provided an extensive bibliography suggesting directions for further historical research.

Lewis conducted a surface survey which located 22 archaeological sites within the area encompassed by McAllister's Site 146 described as the "Ewa coral plain, throughout which are the remains of many sites. . . ." (Lewis 1970:1). Three sites recorded by Lewis (1970) are within the boundaries of Study Area 1b.

By 1975 a deep draft harbor was planned where a limestone quarry was situated, 2 statute miles north of Kalaeloa (Barber's Point). In anticipation of the proposed construction, the United States Army Corps of Engineers contracted for further archaeological work in the area surrounding the existing boat basin where Lewis had worked (Barrera 1975:Figure 2).

Barrera's survey covers the present Optional Area 1 and a portion of Study Area 1a, where he recorded three additional sites: B6-98, T-8, and T-9. The disposition of these sites and all other archaeological features recorded as of 1975, including Barrera's 1975 study, are summarized in Table 1 of his report. This table shows that Lewis's (1970) Sites B6-15 through B6-20, situated around the pond in

Study Area 1b, were not relocated.

The United States Army Corps of Engineers continued the archaeological research in 1976 by requesting another survey of the cultural remains in the area previously surveyed in 1970 and 1975 (Sinoto 1976). Sinoto's work includes mapping of 68 new archaeological sites and more complete mapping of 30 previously recorded sites. In Optional Area 1 alone, the number of known sites increased from 3 to 35, and in Study Area 1b, from one to 6. The sites (excluding B6-58, B6-70, B6-100, and B6-119) comprise parts of the site groups designated 50-80-12-2707, 2708, 2709, 2710, and 2711 by Davis (1978:140-145, Table 8). These sites have been renumbered in this report according to the permanent State of Hawaii site recording system (see Appendix V).

Sinoto's survey (1976) includes a phase of subsurface testing of many sites and salvage excavation of two sites (B6-58 and 2767) within the bounds of Optional Area 1. Tested sites located within the present study areas are listed in Appendix V and in Davis (1978:Table 8). Correlation of Sinoto's test excavation results and the results of additional tests conducted during the present study are provided in Table 1 herein.

Basaltic glass age determination of samples collected at Site B6-58 and Site 2777 (Sinoto 1976:Appendix II) indicates that occupation of these sites occurred late in the prehistoric period (after 1500 A.D.) and terminated before or soon after 1778 A.D. Discoveries of avifaunal and nonmarine molluscan fossils in abundance (Sinoto 1976) moved the scientific community to encourage the Corps of Engineers to conduct limited research in paleontological and paleoecological studies (Sinoto 1978).

In 1977, the Corps of Engineers contracted for salvage excavation of the archaeological features in the proposed harbor area (Sinoto 1978) previously surveyed in part by Lewis (1970), Barrera (1975), and Sinoto (1976). This area is adjacent to the west boundary of Optional Area 1. Results of Sinoto's excavations show that basaltic glass age, style, content, and probable function of habitation sites excavated in 1978 differ little from that of Site B6-58 excavated in 1976. The age estimates are derived from a stratified, buried, cultural A3 horizon contemporaneous with the surface structure. This stratigraphic sequence is found repeatedly in the present study areas.

Sinoto's work for the Corps of Engineers (1978) included preliminary sampling and analytical studies of avifaunal remains and terrestial gastropods (land snails) and a geological study of the emerged coral reef based on the excavation of one sink hole. To complete the archaeological survey of the entire area to be affected by the harbor and support facilities, the Corps contracted for survey of the areas designated in this report as Optional Area 1 and Study Area 1a (Davis 1978) and Area 1b (Sinoto 1979). Those surveys by Davis and Sinoto located numerous archaeological sites, as well as sinks of late Pleistocene to early Holocene age which are of considerable paleontological interest.

The Davis (1978) survey area overlapped a large portion of the Lewis (1970) survey. It concentrated on the coastal strip west of Malakole Road and an area adjacent to and surrounding the future harbor (including Study Area 1a and Optional Area 1) already surveyed by Sinoto (1978). Two areas significant to the present work were surveyed by Lewis (1970) but were excluded from Davis's study area. One is a parcel adjacent to the south boundary of the proposed harbor basin and to the northwest boundary of Optional Area 1 at Malakole Road, which contains salvaged sites recorded by Sinoto in 1978 (refer to Davis 1978:19, Figure 4). The other area excluded from Davis' study (bounded by Malakole Road on the south, Kalaeloa Boulevard on the east, and existing sugarcane fields on the north--designated in our work as Study Area 1b) contains a freshwater pond and the sites recorded by Lewis (1970) and Barrera (1975).

The Davis (1978) survey describes and locates all probable archaeological sites within our Study Area 1a and Optional Area 1 and contains a preliminary botanical and faunal survey, including an inventory of flora and fauna found and an inventory and map locations of rare and endangered flora (Euphorbia skottsbergii and Achyranthes splendens). Davis' work concluded archaeological survey work in Study Area 1a and Optional Area 1 until the present study.

In 1979, archaeological survey work was conducted by Sinoto in Study Area 1b for the Corps of Engineers. This survey located and described all probable archaeological features in those areas. Preliminary work to determine the criteria for selecting sinks with extinct avifaunal material was also conducted during this survey. Sinoto's results show that, although sinks containing remains of extinct species are dispersed throughout the study area, only three (3) of 19 sinks tested (or 15%) contained extinct species, however, this amounts to a considerable number of sinks. Sinoto's 1979 study, as well as that by Davis in 1978, prepared Optional Area 1 and Study Areas 1a and 1b for the salvage excavation phase of archaeological work and the selection of sites for excavation was based primarily on those two surveys.

The bulk of the archaeological work conducted at Kalaeloa up to this point has been descriptive with little or no theoretical observations on hypotheses presented with the exception of Sinoto (1976) and Davis (1978). Sinoto, on the basis of a sample of excavation data, makes propositions concerning the nature of settlement. Davis (1978), on the basis of the survey data (size and area of sites), proposes three classes of structures. These propositions are evaluated in the context of the present excavations in the section "Barber's Point Perspective".

ARCHAEOLOGICAL TESTING

Testing of archaeological sites within Optional Area 1 and Study Areas 1a and 1b, was conducted before salvage excavations to determine each site's potential for yielding stratigraphic evidence of human occupation. All probable habitation features were tested. In addition a sample of nonhabitation features were also tested either because of their proximity to habitation features or because of other special characteristics that implied presence of cultural or faunal material. Table 1 is a list of tested sites according to permanent State of Hawaii site number, correlation of present and previous findings (comments) and the extent of the work performed (work done and justification). The latter includes comments on why further work was not done, in addition, the use of the word artifacts here refers to portable artifacts. For survey data on the site itself the reader is refered to Davis (1978).

The first task was to relocate all previously surveyed archaeological sites (148 in all). Of the 53 sites in Optional Area 1, 51 were relocated. Sites 2603 and 2609 were not identified with certainty. Of the 54 sites in Study Area 1a, 45 were relocated. Sites 2735 and 2736 through 2744 were not found because of very recent logging activities and resulting debris. Of the 40 sites in Study Area 1b, 37 were relocated. Sites 9650, 9662, and 9677 were not found. During site identification, each site was cleared of vegetation and its present condition was evaluated. Site descriptions and test excavations by Sinoto (1976 and 1979) and Davis (1978) provided a basic guide for selecting sites to test.

Test trenches ranged from 25 centimeters square to one meter square and excavation of the test trenches was terminated as soon as the potential of each site for yielding cultural material in a stratified context was determined. Old test trenches (Sinoto 1976) in sites in Optional Area 1 were cleaned out and inspected and data from those trenches were used to evaluate these sites.

The testing revealed stratified Hawaiian occupation deposits in 17 of the archaeological sites tested. Those sites, as well as four (4) sites of historic age, two (2) modified sinks and three (3) burial sinks were selected for salvage. Other sites tested were found to be (1) nonhabitation features with no cultural materials, possibly of prehistoric age; (2) features with no cultural refuse, built by the military for field exercises or possibly by <u>nā</u> <u>paniolo</u> (cowboys) during historic times; or (3) natural features with no cultural refuse.

During test excavations, estimated densities of avifaunal material and terrestrial gastropods were noted to assist Dr. Storrs Olson and Dr. Patrick Kirch in their paleontological research.

TABLE 1

ACCESSION LIST OF TESTED ARCHAEOLOGICAL SITES

Site Number	Trench Number	Comments	Work Done and Justification
Study Areas la and lb*			
2712	la	Site retains physical character described by Davis (1978), associated sub-features present (i.e., filled sink in enclosure is possible hearth, etc.); nearby sinks located.	Site was salvaged because of presence of midden, soil deposits in and around feature, construction design and proximity to the shore Avifaunal and landsnail remains present. Sampled by Dr. Patrick Kirch (Appendix II).
2714	2	Two natural strata present. Site retains physical character described by Davis (1978).	No further work done. Shallow (3-20 centimeter) deposit with little midden. No features present except pebble and cobble interior floor measuring about 1 by 1 meter.
2715	3	Two natural strata present. Site retains physical character described by Davis (1978).	No further work done. No subsurface cultural debris nor stratified cultural unit. No subsurface features.
2716	4	Site retains physical character described by Davis (1978).	No further work done. No stratified cultural unit or subsurface features. Midden consists of less than 2 grams of Isognmon fragments.
2717	5	Site retains physical character described by Davis (1978).	No further work done. No cultural midden or subsurface features present. Interior completely excavated by a 1-meter square trench.

*None of the archaeological features in Areas la and lb were tested previously.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
2719	7	Site retains physical character described by Davis (1978). Two *natural strata present.*	No further work done. No cultural debris or stratified cultural unit. No subsurface features. Ahu dismantled.
2721	9	Site retains physical character described by Davis (1978).	No further work done. No stratified cultural layer. No cultural debris or subsurface features.
2723	1	Site retains physical character described by Davis (1978).	Site was salvaged because of presence of midden, stratigraphic cultural layer, construction design. Sampled by Dr. Partick Kirch (Appendix II).
2725	3	Site retains physical character described by Davis (1978).	No further work done. No midden found in test trench. No visible features in sink. No cultural strata. Probable agricultural use. Samples collected by Dr. P.V. Kirch contains 80% to 90% Assiminea (brackish water snails) (Appendix II).
2727	5	Site retains physical character described by Davis (1978).	No further work done. No midden or artifacts recovered from test trench. Site is in poor state of preservation.
2728	6	Site retains physical character described by Davis (1978).	No further work done. No midden or artifacts found. Absence of soil deposits.
2730	1	Site retains physcial character described by Davis (1978).	Site was salvaged because of presence of midden in two stratigraphic layers within the feature.
2731	2	Site retains physical character described by Davis (1978);	Site was salvaged because of presence of midden in stratified deposit within

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
		possible doorway present.	feature.
2732	3	Site retains physical character described by Davis (1978).	Site was salvaged because of presence of midden in stratified deposit and a subsurface hearth; site is complex with walls and modified sinks with cultural debris are associated.
2733	4	Site retains physical character described by Davis (1978).	No further work done. No midden or artifacts present. Site has been partially destroyed by bulldozing. Interior area of site is small.
2745	1	Site retains physical character described by Davis (1978), hearth present; midden present; adjacent sinkhole located.	Site was salvaged because of midden in two stratified layers; stone-lined hearth partly buried within feature; depth of cultural units exceeds 25 centimeters below surface.
2746	2	Site retains physical character described by Davis (1978).	No further work done. Stratum II is culturally sterile. A poorly constructed wall on west side of sink is probably associated with modern military activity.
2750	5	Site retains physical character described by Davis (1978).	No further work done. <u>Ahu</u> built on top of wire-wrapped stick. <u>Ahu</u>, stick, and wire left undisturbed.
2753	7	Site retains physical character described by Davis (1978).	No further work done. Shallow deposits in bedrock pockets with culturally sterile Stratum II. Threaded metal pipe fitting <u>in situ</u> in Stratum I adjacent to bedrock bottom. A poorly constructed wall west of the

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
			feature is probably a result of modern military activity in the area.
2755	9	Site retains physical character described by Davis (1978).	No further work done. No midden or stratified cultural layer. A rough stacked boulder wall on the west side of the sink is probably the result of modern military activity in the area.
2622	21	Does not correlate with Davis (1978). No cultural midden present.	No further work done. No cultural material or surface features in sink. A rough stacked wall outside the sink is probably connected with modern military activity in the area. Sampled by Dr. Storrs Olson (Appendix I).
2762	22a	Site retains physical character described by Davis (1978).	No further work done. No cultural material visible. Depth and considerable surface overhang makes entry hazardous. Sampled by Dr. Storrs Olson (Appendix I).
2763	22b	Site retains physical character described by Davis (1978); small <u>ahu</u> in sink below the opening not mentioned before.	Site was salvaged because of presence of midden within deposit in sink, depth of deposit <u>exceeds</u> 40 centimeters; small <u>ahu</u> in sink. Numerous landsnail and avifaunal remains present. Sampled by Dr. Storrs Olson and Dr. Patrick Kirch (Appendices I and II).
2765	2	Site retains physical character described by Davis (1978).	No further work done. Shallow deposit with no midden or artifacts. Probably historic.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
2766	3	Site retains physical character described by Davis (1978).	No further work done. Very shallow deposit in test trench (5 cm) and throughout interior of enclosure. No cultural material in deposit. Probably historic.
9646	46	Site retains physical character described by Sinoto (1979).	No further work done. No cultural materials found during testing. Site is very deteriorated.
9647	47	Site retains physical character described by Sinoto (1979).	No further work done. Very shallow soil deposit. No cultural layer. Site is in very poor condition.
9648	48	Site retains physical character described by Sinoto (1979).	No further work done. No soil deposit in or under the platform. No midden or artifacts.
9649	49	Natural geologic formation affected by tree root disturbance.	No further work done. Wide, linear bedrock ridge with sink filled by natural roof fall. No cultural material.
9654	54	Natural geologic feature.	No further work done. Gravity filled sink with no sediments around its perimeter. Forest litter on bedrock only. No cultural material present. "Wall" on east side of sink is formed by naturally faulted blocks caused by solution and tree root disturbance.
9656	56	Natural geologic feature.	No further work done. No cultural material present in or around sink. No sediments around sink. "Wall" at perimeter of sink con-

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
			sists of blocks faulted by solution and gravity (rooffall).
9659	59	Site retains physical character described by Sinoto (1979).	No further work done. No cultural materials found in testing.
9661	61a	Site retains physical character described by Sinoto (1979).	No further work done. No stratified cultural layer. No cultural material within the enclosure. Two to 5 centimeters of modern humus on bedrock.
9661	61b	Site retains physical character described by Sinoto (1979).	No further work done. Culturally sterile Stratum I (A horizon) and Stratum II. Shallow deposits 5 to 20 centimeters deep in pockets in bedrock. Also a fine silt layer outside the entrance of enclosure.
9664	64	Site retains physical character described by Sinoto (1979).	No further work done. Irregular, nondescript surface features. Shallow or nonexistant soil deposits. No stratified cultural layer in test trench; No cultural debris in trench, on surface, or in sink within "complex". Probably caused by bulldozing.
9665	65	Site retains physical character described by Sinoto (1979).	No further work done. No cultural deposit or material present. Boulder cobble rubble on bedrock bedrock is not sorted or stacked. Probably caused by pasture or field-clearing.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
9669		Site retains physical character described by Sinoto (1979).	Site was salvaged because of presence of midden within deposit in sink; depth of deposit exceeds 30 centimeters. Numerous landsnail and avifaunal remains present.
9670	70	Modification is a result of bulldozing.	No further work done. Modification of sink (i.e., large boulders covering opening) is caused by bulldozing and uprooting of trees. Access to sink requires ladder or ropes because of undercut surface edge.
9676	76	Site retains physical character described by Sinoto (1979).	No further work done. Platform contains no midden or artifacts and is constructed on sterile soil (C horizon). No cultural deposit was found under the structure. Structure is in poor state of preservation.
9679	79	Site retains physical character described by Sinoto (1979).	No further work done. No midden or artifacts found during testing. Site is in poor condition.
9682	82	Site retains physical character described by Sinoto (1979); has a terrace; pavement in enclosure.	Site was salvaged because of presence of midden in stratified cultural layer 10 centimeters deep; construction features, proximity to fresh water pond.
9683	83	Site retains physical character described by Sinoto (1979).	No further work done. No cultural materials recovered from test trench. Shallow soil deposit on coral substrata.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
9684	84	Site retains physical character described by Sinoto (1979).	No further work done. No cultural materials recovered from the test trench.
Optional Area 1			
2768	1	Reopened previous test trench (Sinoto 1976:35). Apparent pavement is faulted bedrock slabs with fine silt (Stratum II, 10YR 6/4) in cracks. This layer contains no cultural material. Stratum I is an A horizon and contains cultural material. Site retains physical character described by Sinoto (1976) and Davis (1979).	Site was salvaged because of presence of midden and construction features.
2769 2770	2f & 2g	Two ahu are well constructed of slabs and cobbles, but disturbed by tree roots. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done. Ahu partially dismantled and the soil beneath was tested. No stratified layer, midden, artifacts or subsurface features were present. Located on periphery of large disturbed area.
2771	3a	Ahu constructed of about 10 small boulders piled on bedrock. No soil present. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done. Feature is located on survey map.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
2772	3b	Ahu of small boulders. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done. Ahu partially dismantled. Layer beneath it consisted of 4 to 5 centimeters of humus on bedrock. No cultural material present. Situated on the periphery of disturbed area.
2773	4	Ahu constructed of slabs and boulders. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done. Recommended for soil profile. Soil beneath ahu is shallow (less than 30 centimeters). Situated in a disturbed area.
2774	5	Ahu, constructed of boulders and cobbles. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done. No stratified deposits present; ahu situated on bedrock in middle of a bulldozed area.
2775	none	Site location uncertain. Numerous natural features in this locality fit description given by Davis (1978).	No further work done. Area largely disturbed by logging evidenced by chain saw cuts on kiawe stumps; numerous uprooted trees.
2776	7	Sink located; modification of sink restricted to cobble and boulder fill. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done. Additional fill to level sink is characteristic of road-making for logging activities.
2777	1a & 1b	Rectangular enclosure with entrance. Re-opened previous test pits (TP1 and TP2 [Sinoto 1976:35]), depth of deposits	Site was salvaged because of presence of cultural midden and artifacts, stratified cultural layer and construction features.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
		vary from 10 to 40 centimeters. Midden present. Site retains physical character described by Sinoto (1976) and Davis (1978).	
2778	2a	C-shaped structure. Previous test trench reopened (Sinoto 1976: 34), two stratified layers present. Site retains physical character described by Sinoto (1976) and Davis (1978).	Site was salvaged because of presence of stratified cultural layer containing midden and construction features.
2779	2b	Disturbed structure. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done because of disturbed state of feature. Test excavation revealed very shallow deposit consisting of two natural layers. No cultural midden or stratified cultural layer present. Shellfish remains fossilized (not cultural material). Charcoal present in the A horizon, probably resulting from modern fires.
2780	3a	Referred to as C-shape (Davis 1978, Sinoto 1976).	Site was salvaged, based on recommendation of State Parks archaeologist. Stratified deposit consists of shallow modern A and O horizons on bedrock. Recent metal artifacts (coffee can, gas can, aluminum bar) present around site.
2781	3b	C-shape located. Site retains physical character described by Sinoto (1976) and Davis (1978).	Site was salvaged based on recommendation of SHPO archaeologist. Fishbone midden recovered from test excavation although deposit in site is shallow.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done .nd Justification
2782	none	Site not found. Area where site is situated is very disturbed by up-rooted trees. Referred to as a C-shape by Davis and as a short wall segment and modified sinkhole by Sinoto (1979).	No further work done because of state of site (Davis 1978). Vertical slabs in this locality are bedrock blocks raised by uprooted trees.
2783	5	Davis (1978) gives same Bishop Museum number for this site and Site 2709-4. Located adjacent to unmodified sinkhole, nondescript wall segment, ahu on sink rim. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done because of undiscernible nature of the feature, the absence of stratified deposits beneath the feature and the absence of cultural material.
2784	6	Sink, modified by construction of wall around sink rim. Previous test trench (Sinoto 1976) reopened. Two layers present, depth of deposit exceeds 30 centimeters. Historic artifact (segment of rubber hose) present not mentioned by Sinoto or Davis. Site retains physical character described by Sinoto (1976) and Davis (1978).	Site was salvaged because on presence of shell midden, charcoal, bird-bones (Sinoto (1976) and numerous land-snails.
2785	7	Sink extending below ground water level; contains clear water. Access is facilitated by stepped modification. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done because of absence of cultural material in deposits under stepping stones.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
2786	1	Reopened Bishop Museum test trench. Two strata present, cupboard in wall present, structure retains physical character described by Sinoto (1976) and Davis (1978).	Site was salvaged because of presence of midden recovered during Museum test excavation; presence of stratified cultural layer, construction design of feature.
2787	2	Reopened Bishop Museum test trench. One stratum present over bedrock, 15 centimeters deep in pockets. Screening of backfill yielded fish scales, turbo operculum, and sea urchin body parts. Site retains physical character described by Sinoto (1976) and Davis (1978).	Site was salvaged because of presence of midden and cultural layer and because of construction design of feature.
2788	3a & 3b	Description given by Davis (1978) most appropriate. Structure disturbed and again very recently by a modern access road for logging. Test Trench 3a revealed a deposit of modern humus (5 centimeters deep) on bedrock. Test Trench 3b revealed a humus layer 10 to 15 centimeters thick on bedrock with Stratum II (10YR 6/4 avg., fine silt) in pockets of bedrock to maximum depth of 25 centimeters. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done because of disturbed state of feature, and absence of a stratified deposit.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
2789	4	Enclosure, core-filled wall foundation, large portions of walls are robbed of rocks (possibly incorporated into historic rail car bed, Site 2791). Site retains physical character described by Sinoto (1976) and Davis (1978).	Site was salvaged because of construction features and presence of sparse surface midden.
2790	5a &	Sinkhole with stratified cultural layer. Previous Bishop Museum test trenches reopened. At least two undisturbed stratigraphic layers are present; deposit contains birdbone in Stratum II not recorded by previous testing by Sinoto (1976:46). Site retains physical character described by Sinoto (1976) and Davis (1978).	Site was salvaged because of presence of stratified culture-bearing layer in deposit in sink; sink near Sites 2786 and 2787 (enclosures with cultural deposits), presence of subsurface features in sink deposit.
2791	none	Railbed and rail sections located. Low, wide wall forming bed uses core-filled wall construction technique. Site retains character described by Sinoto (1976) and Davis (1978).	Limited survey work done. Further tracing of undisturbed segments has provided all significant data.
2792	none	Oriented perpendicular to railbed, so probably not an extension of the railbed. Core-filled construction technique. evident. Iron bar noted by Davis (1978:142) is not present. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done. Very disturbed state.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
2793	none	Feature not located.	Voided as individual feature. Location on map and description indicate that feature is probably a "short deteriorated abutment" (Sinoto 1976:20) uitlized in railbed design.
2794	8	Ahu of cobble and boulder construction, square plan view. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done. Feature is built on *in situ* weathered bedrock with humus in interstices of bedrock blocks. No cultural materia present.
2795	none	Ahu, disturbed by uprooted tree. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done. Feature is built on bedrock; no soil layers are present.
2796	10	Sink located, platform present in sink. Two strata present. Deposit is less than 20 centimeters deep. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done because of absence of stratified cultural layer, midden and subsurface features. Platform in sink bottom probably built for military field exercises. Another sink located 5 meters to the north is filled with historic military-related artifacts.
2797	11	Ahu formed by slab boulders stacked around the rim of the small sink. Diameter of opening in top of ahu is 25 centimeters. Ahu serves as extension of sink depth. Site retains physical character described by Sinoto (1976) and Davis (1978).	Site was salvaged because of unique form and proximity to historic railroad berm.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
2798	12	Unmodified sink; natural faulted blocks form "wall" on sink rim. Depth of deposit exceeds 40 centimeters. Birdbones and land snails present in Stratum II.	No further work done. Potential significance for avifaunal and landsnail sampling, based on absence of cultural material and presence of deep deposit in sink bottom.
2799	none	Sink not located. It is situated in the midst of numerous sinks which fit the given description (Davis 1978:143). Probably natural feature.	No further work done. Sinks in this vicinity may be selected for avifaunal or landsnail samples.
2603	none	"Midden sink hole" (Davis 1978:143) not found. Probable map error. Sink with historic military material adjacent to Site 2796 fits description for Site 2603. Site situated at map location for 2603 is modern rubble pile containing coral, basalt, and cement rocks. This rubble pile is identified by flag as B6-64 described by Sinoto (1976) as two short wall segments.	No further work done. No sites in the immediate vicinity of the map location are deemed signifïcant for archaeological research. Recent logging operations have disturbed surrounding area.
2604	1	Three-sided enclosure, in good condition. Large stacked slab construction. Probably historic. Site retains physical character described by Sinoto (1976) and Davis (1978).	Site was salvaged based on recommendation of SHPO archaeologist. Cultural material and stratified cultural layer absent; historic construction features; situated adjacent to large, disturbed areas.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
2605	none	Feature not located due to dense vegetation and presence of numerous natural areas fitting description of feature given by Davis (1978:143).	No further work done.
2606	5a & 5b	*Ahu*, both small nondescript piles. Site retains character described by Sinoto (1976) and Davis (1978).	No further work done because of absence of cultural material when *ahu* was dismantled.
2608	7	*Ahu* located. Site retains physical character described in Sinoto (1976) and Davis (1978).	No further work done because of absence of cultural material when dismantled. Feature is disturbed and in a poor state.
2609	none	Sink located by Davis's (1978) map. Skeletal remains thought to be human are *pteradroma phaeopygia (petrel)*. Site retains physical character described by Sinoto (1976) and Davis (1978).	Salvage excavations necessary based on presence of skeletal remains. Site was tested but no human skeletal material was found.
2610 2611 2612	none	Sinks located, few boulders on sink rims are natural, sinks generally deep with narrow openings with deeply undercut walls.	No further work done. Sinks were inspected by Dr. Storrs Olson.
2731	none	Sink located, situated in area where *Euphorbia sp.* is found. Modification may be natural formation previously disturbed. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done because of absence of surface cultural midden. Sink may be selected for avifaunal sampling.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
2713	none	Sink located; "pit" in sink deposit noted by Davis (1978:144) apparently not Bishop Museum test (Sinoto 1976:18). Referred to as "midden sinkhole" by Davis, but only bird and rodent bone noted. Sink retains physical character described by Sinoto (1976) and Davis (1978).	No further work done. Sink may be selected for avifaunal sampling.
2714	18	Sinkhole modified with irregular stacked wall. Site retains physical character described by Sinoto (1976) and Davis (1978).	No further work done because of absence of stratified cultural layer and midden. Construction features of wall indicates historic age. Avifaunal and landsnail sampling potential is good. Depth of deposits exceeds 40 centimeters.
2715	none	Sinkhole not modified.	No further work done. Sink has good avifaunal and landsnail sampling potential.
2716	20	Sink not modified.	No further work done because of absence of stratified cultural layer and midden. Avifaunal and landsnail sampling potential good.
2617	22a & 22b	Clearing is result of recent logging or bulldozing activities; soil accumulation is slope runoff from existing cane fields. Limestone slabs on edge (Davis 1978:144) are result of uprooted trees. Trench 22a revealed two	Site was salvaged based on presence of cultural material.

TABLE 1 (continued): Accession List of Tested Archaeological Sites

Site Number	Trench Number	Comments	Work Done and Justification
		culturally sterile stratigraphic layers. Trench 22b revealed remnant of a stratified cultural layer adjacent to sink complex.	
2718	none	Clearing is result of recent logging or bulldozing activities. Soil accumulation is result of slope run-off from exist-cane fields.	No further work done. Area is disturbed; no surface features or remnants of archaeological significance are present.
2719	none	Sink is not located precisely. Situated in a sink complex with numerous unmarked flags.	No further work done because of absence of cultural midden. Avi-faunal and landsnail sampling potential is good.
2720	none	Sinkhole located, skeletal remains present. Site retains physical character described by Sinoto (1976) and Davis (1978).	Site was salvaged because of presence of skeletal material.
2721	none	Sinkhole located, skeletal material present. Sink is modified in interior to conceal bones. Site retains physical character described by Sinoto (1976) and Davis 1978).	Site was salvaged because of presence of skeletal material and physical modifications to sinkhole.

PALEONTOLOGICAL SITES

One purpose of our study was to conduct paleontological research within the limits of the study area to mitigate the impact on these scientific resources. Barber's Point deposits have two potentials:

1. To provide material for comparision to other fossil assemblages on Kaua'i, Moloka'i, and Hawai'i for the purpose of analyzing the fossil and evolutionary history of the Hawaiian avifauna.

2. To document the hypothesized contemporaneity of Polynesian (Hawaiian) culture and an extinct avifauna, particularly the relationship of avifaunal extinction to habitat destruction caused by human colonization of Hawaii.

Dr. Storrs Olson and Miss Helen F. James of the Smithsonian Institution conducted research on fossil avifauna (Appendix I). Nine sink holes were investigated (Table 2, Page 59), as well as many unnumbered sinks throughout the project area. One of the nine sinks (2763) contains cultural deposits and the other eight are noncultural. Sub-fossil bird bones associated directly with cultural material in 2763 consist exclusively of Pterodroma phaeopygia (dark-rumped petrel). The other eight (noncultural) sinks contain bones of extinct land birds, as well as petrel. Sink 2624 is by far the most important and contains fossils of all previously known species from Barber's Point, and eight species never before identified on O'ahu. Six of these new species were small forest birds. The former presence of these forest birds has implications for the reconstruction of changes in the ancient environment. A descriptive summary of Site 2624 follows.

DESCRIPTION

Site 2624 (Figures 7 and 8) is a roughly oval sink complex, measuring 1.5 by 3.5 meters, has a "floor" area of 3 by 4 meters, and is 4 to 5 meters deep. Because of its relatively large size and deep soil deposit, this sink was chosen for avian paleontological study.

EXCAVATION RESULTS

Six trenches were excavated at Site 2624. These trenches were dug along the perimeter of the sink "floor" because of the higher concentrations of avifaunal remains. The stratigraphic units present in the excavation are described as follows from topmost to lowest.

UNIT I — A horizon (10YR 2/2 moist), silt loam with fine angular granule to pebble limestone. Thickness averages from 2 to 5 centimeters. The boundary is abrupt and wavy. High percentage of carbonate. No cultural material present. Landsnails common; bird bone material is recent.

UNIT II — A3 or very weak Bir horizon (7.5 YR 4/4, moist). Matrix of silt loam with granule to gravel and pebbles. Weak subangular blocky structure. Some weak verticle orientation, slightly sticky, slightly plastic. Average thickness is from 3 to 10 centimeters, with a deeper deposit in the southeast corner of the sink. Most avifuanal remains were located within this unit. No cultural material is present. Land snails are present. High percentage of carbonate. Weak structural B horizon.

UNIT III — C horizon (10 YR 5/3 moist) silt loam with fine gravel, slightly sticky, slightly plastic, massive structure. Granule size limestone decreases with depth. Color whitens with depth influenced by neutral color of carbonate. Ten to greater than 25 centimenters in thickness.

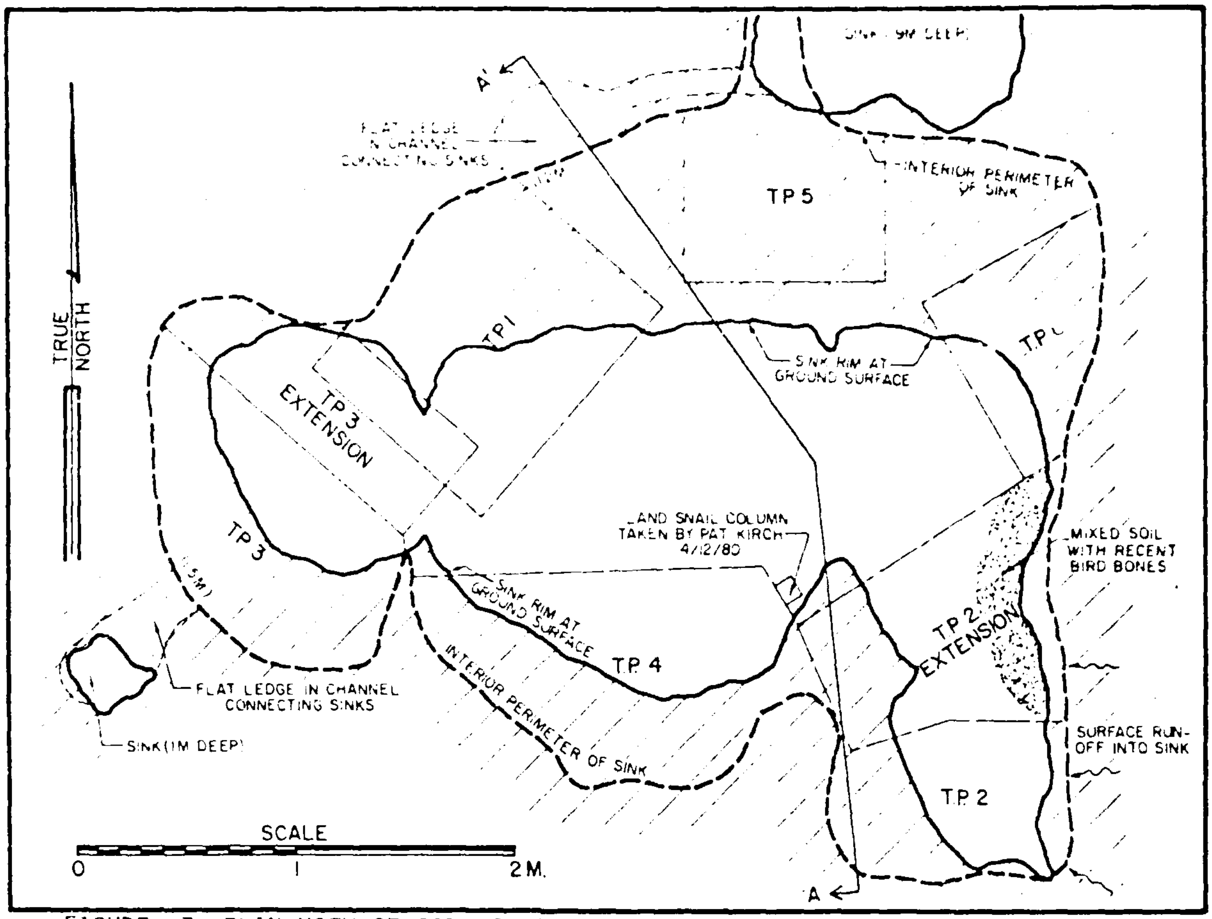

FIGURE 7 PLAN VIEW OF SITE 50-80-12-2624, SHOWING EXCAVATION TRENCHES.

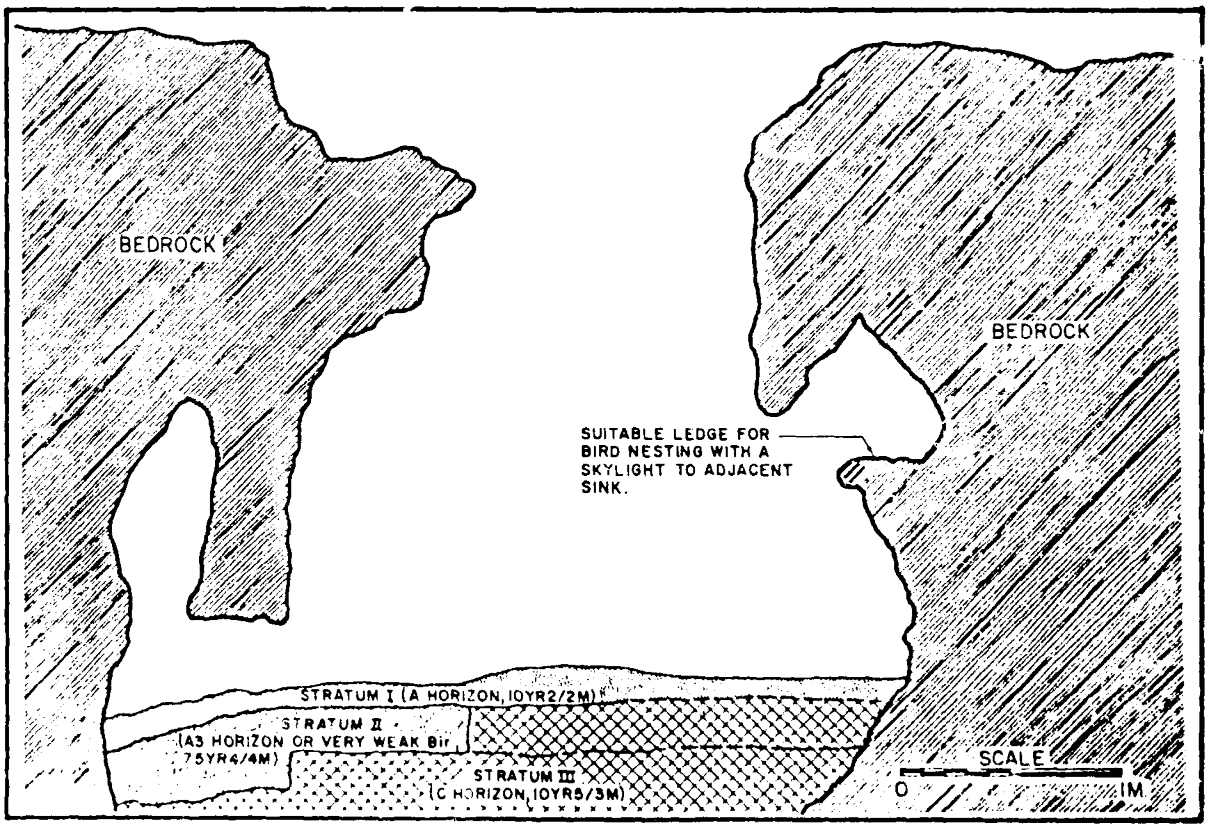

FIGURE 8 X-SECTION A-A' OF SITE 50-80-12-2624, SHOWING STRATIGRAPHIC LAYERS.

In summary, the stratigraphic profile of Site 2624 shows:

1. One phase of soil develoment.

2. A similar mode of deposition for all layers, i.e., aeolian silt reworked into the sink by water and mixed with colluvial limestone rooffall.

3. Stratum II is a weak color and structural Bir horizon with characteristics of a spodisol (forest soil).

Dr. Patrick V. Kirch and Dr. Carl C. Christensen of the Bernice Pauahi Bishop Museum conducted research on terrestrial gastropods (see Appendix II). Five column samples were retrieved for land snail analysis from four archaeological sites (refer to Table 2) and one column from paleontological Site 2624. The archaeological sites sampled were 2763, 2725, 2723, and 2712 (from which two columns were taken). The column from Site 2763 was not analyzed. The species of gastropods was separated into three groups for analysis: native extinct; native extant; and introduced (both Polynesian and modern introductions). These groups represent between 21 to 25 separate species. The tentative conclusions resulting from the analysis are as follows:

1. A temporal sequence divided into three periods is indicated: (a) a prehuman contact period, characterized by arid parkland with open canopy trees; (b) prehistoric utilization/occupation, characterized by habitat disturbance and decreasing vegetation cover; and (c) recent (post-contact) period with dramatic change in vegetation and introduction of exotic species.

2. A tentative association of Polynesian-introduced snail species with assemblages of extinct avifauna.

In evaluating these tentative conclusions, it is essential to consider stratigraphic context, particularly, degree of soil mixing by plants and animals. The conclusions to date on the paleoenvironmental work conducted for this study at Barber's Point (see page 197) are formulated on the basis of critical analysis and of a balanced synthesis of archeological, paleontological and paleoecological data.

Preliminary results from landsnail analysis were received before the field work was completed. Based on these results, especially the presence of (Assiminea nitida) in Site 2725, which is a possible indicator of prehistoric horticultural practices, additional sample columns were extracted from Sites 2712 (adjacent sinks), 2778 (adjacent sink), 2784 (sink), and 2786 and 2787 (adjacent sinks). Selection of these additional sinks for testing and sampling was based on the characteristics of Site 2725, a sink with a shallow-lying soil deposit and a large opening, situated near an archaeological site. Other sites dissimilar to Site 2725 were probably used for horticulture, but the additional samples from sinks similar to 2725 will complement the data base in future laboratory analysis.

TABLE 2

ACCESSION LIST OF ARCHAEOLOGICAL SITES
TESTED FOR AVIFAUNAL AND LANDSNAIL REMAINS

Site Number	Preliminary Findings	Paleontological Findings
2712	Enclosure; avifaunal and land snail remains in association with cultural materal, numerous sink holes nearby with good soil deposits.	Sinks adjacent to the site have shallow-lying soil floors or soil floors below ground water level. Two column samples were collected from the cultural layer by Dr. Kirch (see Appendix II).
2723	L-shaped structure; no avifaunal remains identified in test excavation. Land snail remains present.	Sinks adjacent to the sink have shallow-lying soil floors or no sediments and are not suitably productive.
2725	Modified sink; no cultural refuse present. Stratified deposits contain numerous snail shells and few birdbones. Wide, shallow sink.	Sink has a shallow-lying soil floor. Low productivity potential for fossil avifauna. Column sample collected by Dr. Kirch (Appendix II) contains high percentage of brackish water amphibious snail shells.
2755	Modified sink, historic; fossilized land snail present, two stratified layers contain quantities of land snail shells, only one birdbone recovered from test trench. No cultural material present.	Sink and others adjacent have shallow-lying soil floors and few birdbones. This site was not sampled for land snail analysis.

NOTE: Sites 2623 and 2624 are not accessioned as archaeological sites but are included in this table. All other sites were previously accessioned by Davis (1978) or by Sinoto (1979) but not all sites contain stratified cultural remains.

TABLE 2 (continued): Accession List of Archaeological Sites Tested For Avifaunal and Landsnail Remains

Site Number	Preliminary Findings	Paleontological Findings
2622	Deep modified sink with wide opening and soil deposit exceeding 30centimeters in depth. Birdbones and land snails present in significant quantities. Living land snail was found in this sink. No cultural material present.	Sink fits criteria for good productivity and was partially excavated. Extinct and extant species are present in moderate amounts; (Appendix I). This sink was not sampled for land snail analysis.
2762	Deep modified sink with wide opening and soil deposit. Sink was not entered due to difficulty of access (i.e, 4 meters deep with deeply undercut walls) however, land snails were found on surface of soil deposit within sink. No cultural materials were observed; living land snails present.	Sink fits criteria for good productivity but contains recent avifaunal remains only. This sink was not sampled for land snail analysis.
2763	1.5-meter deep sink containing birdbones, land snails, and cultural material in a deep (more than 40 centimeters) soil deposit in sink.	Sink contains stratified cultural deposits with large quantities of petrel bone midden and some extinct species (Appendix I; also refer to Archaeological Excavations, Site 2763 in this report. This sink was sampled for landsnail analysis but sample was not analyzed (Appendix II).
9655	Sink not previously tested. Similar in characteristics to Site 9656 but no buried A horizon.	Sink was partially excavated. Birdbones present are primarily petrel. This sink was not sampled for land snail analysis.
9656	1.5-meter deep sink containing many birdbones in good condition. Three stratigraphic layers present in deposit exceeding 60 centimeters in depth. With a	This sink and others in the vicinity are only moderately deep with thick deposits of soil of lesser age. Avifauna are predominantly petrel. This sink was not sampled

TABLE 2 (continued): Accession List of Archaeological Sites Tested For Avifaunal and Landsnail Remains

Site Number	Preliminary Findings	Paleontological Findings
	buried A horizon. All layers contain bird and land snail remains. No cultural material associated. A nearby untes'ed sink, Site 9655, may have a similar deposit.	for land snail analysis.
9659	Large 1.5-meter deep sink with wide opening, contains shallow (25-centimeter) deposit of two natural stratified layers with many land snails. Depth of deposit may exceed 25 centimeters in some areas within sink. No cultural materials present.	Sink opening is wide but sink is only moderately deep and soil deposit is thin, few birdbones. This sink was not sampled for land snail analysis.
2623	Noncultural sink in the vicinity of Site 9661, selected for testing by Dr. Olson during field inspection of this area.	Sink fits criteria for good productivity but tests were not suitably productive (Appendix I). This sink was not sampled for landsnail analysis.
9669	Large 1.5-meter deep cave-shaped sink with wide opening; contains numerous land snail remains and some bird bones associated with cultural midden. Deposit in sink exceeds 30 centimeters in depth. Sink is situated on elevated section of raised reef and thus receives less slope-washed material.	Sink is moderately shallow with thick soil deposit but is young and is not suitably productive. This sink was not sampled for land snail analysis.
2624	Noncultural sink selected for testing by Dr. Olson during field inspection of this area.	Sink is of great paleontological significance and contains fossil avifauna of extant, extinct, and previously undescribed species (Appendix I). Column sample was taken from the central unexcavated portion of the soil deposit in this sink (Appendix II).

ARCHAEOLOGICAL EXCAVATIONS

FIELD AND LABORATORY METHODS

Archaeological sites (discreet structures and sinkholes containing evidence of construction or modification) surveyed by Davis (1978) in Optional Area 1 and Study Area 1a and by Sinoto (1979) in Study Area 1b were relocated by survey stakes and markers and, in some cases, by remnants of inscribed survey flags. Most of the sites were superficially cleared and specific sites were selected for test excavations on the basis of field evaluation and secondarily the previous surveys' recommendations. All relocated sites in Study Area 1b were reflagged and inscribed with the State of Hawaii system site number, while in Area 1a and Optional Area 1 with Davis' (1978) numbers. Results of the test excavations (see page 35) formed the basis for selecting 25 sites for salvage.

Salvage was conducted according to standard ARCH field methods. Each site was excavated as a separate entity by means of a metric grid system, oriented, in most cases, to the axes of the structures. Compass directions mentioned in the site descriptions are relative to each site's N-S baseline in lieu of magnetic or true compass bearings. The excavation strategy consisted of defining the center of concentration of cultural material at each site. This was done on the basis of distribution of fine textured sediment, bedrock configuration and the exisiting surface structure. Excavations were expanded in all directions to the point at which cultural material became slight or non-existent. On the average, 50 percent of the horizontal extent of each site was excavated with emphasis on structure interiors, entranceways and immediate exteriors. The excavation plan for each site varied depending on configuration of the structure itself and its accompanying cultural deposits. In the case of the smaller sites (and many larger ones) the entire structure was removed after detailed recording and all cultural deposits excavated under and around them (the excavated areas of each site are shown in individual plan views, Figures 7 through 79).

Records were made of portable and nonportable artifact locations, midden and detritus distribution for each square meter excavated. These records included trench designation, quad designation, level, stratum, feature association and special remarks. Every artifact recovered was designated with a location code according to circumstances of recovery as follows: Code 1 - found and recorded in place with exact vertical and horizontal provenience, Code 2 - located to quadrant of a 1 meter square within a certain level and stratum (usually found during screening), Code 3 - located to a 1 meter square within a certain level and stratum, and Code 4 - located to the site but with no grid level or stratum provenience (generally scattered surface finds). Clearly the goal was to locate all finds as Code 1, however, this system has the flexibility to accomodate all levels of provenience. The Code 1, 2 and 3 finds were used to tabulate the density maps for analysis of activity areas and spacial relationships essential to this study. Midden materials were bagged as Code 2 initially until it became apparent (due to small quantities and mixing of deposits) that provenience recording to Code 3 would provide information necessary to discern disposal patterns. Stratigraphic profiles, and horizon descriptions of each site have been supplemented by photographic records and additional descriptive notes and profiles contained in field notebooks.

All archaeological sites (except B6-58, B6-70, B6-100, and B6-119) within the study areas have been assigned permanent numbers according to the state of Hawaii's system (where for example, for 50-80-12-2723, 50 is the state of Hawaii, 80 the Island of O'ahu, 12 the U.S.G.S. 7½ Minute Series topographical map index number, and 2723 the unique State of Hawaii site number). In this report sites are sometimes referred to by only their unique numbers.

During the test excavations, archaeological sites that contained bird bone material or land snail shells were recommended for further field inspection by Dr. Storrs Olson of the Smithsonian Institution and Dr. Patrick V. Kirch of the B. P. Bishop Museum.

Temporary field numbers were assigned to two sites selected for further excavation by Dr. Olson. The number of the nearest archaeological site (9670 and 9661) was used with the suffix P1 to identify the site as a paleontological sink. The sites have been assigned permanent numbers.

Artifactual and midden materials were treated and handled according to standard ARCH laboratory methods. Each specimen in the artifact assemblage was assigned a unique number (consecutively from one to 482) prefixed by the permanent site number. Gross measurements, including length, width, thickness, and weight, a verbal description, and provenience information for each specimen comprise the Master Artifact Catalog (Appendix IV). Unstable specimens (primarily shell and bone) were treated; chemicals and percentage solutions used were recorded on individual conservation history record forms for each treated specimen. After conservation treatment, each artifact was labeled with an abbreviated accession number (e.g., for 80-2723-483, 80 is the Island of O'ahu, 2723 the unique site number, and 483 the unique specimen number) which corresponds to a descriptive analysis in the Master Artifact Catalog. Each artifact was photographed for permanent records.

Midden material was sorted by species, genus or family (for shellfish) and material (e.g., charcoal, coral, basalt, bone). Bone was specified as bird, fish, and mammal and sorted to species where possible. Each component was weighed and recorded by provenience. The bird bone component of the midden was sent to Dr. Olson for identification and selective dating.

Radiocarbon analysis was done by Beta Analytic, Inc. This consultant was chosen over that mentioned in the research design because of the more efficient service which they provide. Basaltic glass and charcoal age determination were used as the basis for estimating the ages of archaeological sites. The basaltic glass samples were prepared by Dr. William Kikuchi of Crafts Hawaii and dated by Archaeological Research Center Hawaii, Inc., Geology-Hydration Rind Dating Department. Crafts Hawaii and Archaeological Research Center Hawaii, Inc. were selected to perform the basaltic glass study because of more expedient service and because the analysis could be tailored to suit the needs of the research project.

It was originally intended to send samples for pollen analysis to the Palynology Laboratory at Washington State University, however, this proved unfeasible because of their lack of a comparative collection. Therefore, samples are being submitted to Dr. Moriarty of the Palynology Laboratory at Kauai Community College.

SUMMARY OF EXCAVATED SITES

Site 50-80-12-2712

Description

The surface component of this site consists of a large, nearly square (5 by 5 meters) four-sided enclosure constructed of limestone boulders, cobbles, and pebbles, utilizing a core fill design (Figure 9). The walls are well made and numerous slabs are set on edge (upright) for facing of the wall. An uprooted kiawe tree has disturbed the northeast corner of the structure. A prominent entrance is present in the approximate center of the south wall. The sides of this entrance are lined with upright stones and the surface is paved with small slab boulders of limestone. The interior of the enclosure is roughly leveled with a pebble and cobble pavement.

Three other features are present in the structure. These are:

1. A small (approximately 80-centimeter diameter) sink hole situated in the east portion of the enclosure interior containing a large upright slab which supports small stones around the sink perimeter so that the opening is constricted to 30 centimeters by 40 centimeters.

2. A roughly constructed, semi-circular shaped, stacked boulder wall occupies the west portion of the enclosure interior. The rocks are not closely fitted together and the wall is one to 3 rocks thick.

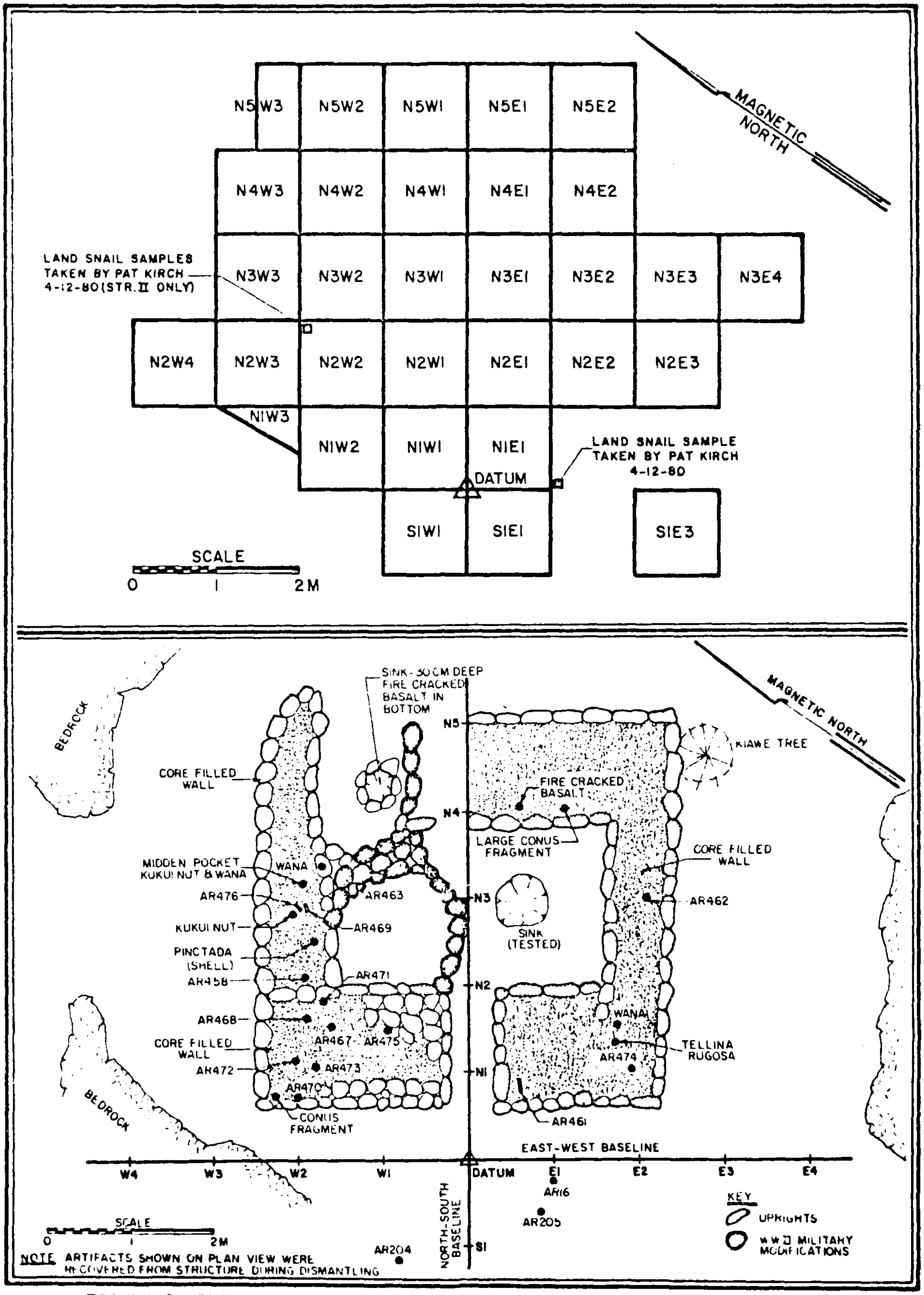

FIGURE 9 PLAN VIEW OF SITE 50-80-12-2712, SHOWING EXCAVATION GRID.

3. A conspicuous gap in the north wall is the result of the earlier removal of rocks from this part of the structure.

The area surrounding this site consists of exposed reef limestone bedrock. One of the numerous sink holes in the immediate vicinity of the site contains brackish ground water at high tide. Nine (9) other surface features consisting of small enclosures, ahu, and a wall are located close to Site 2712. (Refer to Davis 1978.)

Excavation Results

The surface structure of Site 2712 was dismantled to ground level to allow for excavation of the subsurface wall foundations. The excavation trenches encompassed nearly 32 square meters, covering the interior area of the site and the deposits beneath the south and west walls. The north and east walls were sectioned to determine their relationship to the stratigraphic layers present. Additional trenches outside the entrance were excavated to determine whether or not a hearth was present there as noted by Davis (1978). Finally, a single trench (S1E3) was excavated outside the southeast corner of the site to determine the horizontal extent of Stratum II in that area.

The sediments in Site 2712 consisted of four (4) stratified layers. These stratigraphic units are described from uppermost to lowest.

UNIT I — Recent 0 and A1 horizons. Very dark brown (10 YR 2/2) loosely consolidated, gravelly, pebbly silt loam with humus and containing 40% limestone gravel and 20% limestone pebbles by volume. It ranges from a few to 15 centimeters in thickness, has a clear wavy boundary, and contains cultural midden and artifacts.

UNIT II — A3 horizon. Very dark grey to very dark greyish brown (10 YR 3/1, 10 YR 3/2), loosely consolidated to compact, gravelly pebbly silt loam, containing 20%

to more than 50% gravel and 10% to more than 50% pebble by volume. The unit ranges from a few centimeters to 42 centimeters thick. It has a clear, irregular lower boundary. Coarse and medium roots are common; and very fine roots occur in very consolidated masses in isolated localities. Cultural material is dense and an isolated lens of limestone gravel, charcoal, charcoal stained dirt (10 YR 2/1), and light colored ash is present beneath the south wall in Trench N2W2.

UNIT III (1) Brown (7.5 YR 5/4, moist) very gravelly silt loam occurs primarily in solution sinks; and,

(2) Light yellowish brown (10 YR 6/4 moist) gravelly fine silt loam of weak fine to medium subangular blocky structure. It is friable, very slightly sticky, very slightly plastic and weakly cemented.

Unit III is culturally sterile except in disturbed areas where reworked S ratum III may contain a few shellfish remains.

UNIT IV C horizon. This unit is comprised of reef limestone bedrock, chemically weathered, and contains numerous solution sinks.

The dismantling of the enclosure walls of Site 50-80-12-2712 revealed approximately 14 artifacts. Preliminary interpretation of the artifact assemblage shows two patterns:

1. Military Springfield rifle shell casings (.30 cal.) and spent clips were concentrated around a semi-circular shaped stacked boulder wall that occupies the west portion of the enclosure interior. This find supports the hypothesis that this sub-

feature was constructed during the 1940s and that the materials (rocks) utilized were obtained from the "conspicuous gap" in the north wall of the structure (Figure 9).

2. Prehistoric (?) traditional Hawaiian tools and products of manufacture were concentrated near the entrance of the structure. This pattern is made more evident by artifact and midden distribution in Stratum (Unit) II, the prehistoric (?) occupation layer.

Results of excavations are discussed below sequentially from the uppermost to the lowest (refer to Figures 10 through 13.)

The materials derived from Stratum I show that this layer is of recent origin and contains artifacts of historic age. Evidence of the upward reworking of cultural remains from Stratum II includes prehistoric (?) artifacts and typical traditional Hawaiian food refuse. The historic artifacts are concentrated in the immediate vicinity of the semi-circular stacked wall feature in the western, interior portion of the site and in adjacent walls. This "modern" assemblage consists of .30 caliber shell casings and spent clips and a live .50 caliber round.

Midden recovered from Stratum I consists of shellfish remains, that probably originated from reworked Stratum II material.

Stratum (Unit) II contained only prehistoric cultural material. The artifact assemblage from Stratum II consists of shell material (Isognomon and Pinctada) and mammal bone fragments in various stages of transformation into fishhooks, coral abrading and cutting tools, a lava (scoria) abrader, waterworn basalt and coral pebbles and cobbl with evidence of use as hammerstones, a bone (bird?) pick, a sandstone flake, eight (8) basalt flakes and a reef limestone flake. Two (2) of the basalt flakes are adz flakes which show a high polish on the dorsal face.

Midden material derived from the excavation of Stratum II consists of gastropods, pelecypods, echinoderms, crustacea, mammal, fish, bird, and rodent skeletal parts, kukui nut shell, charcoal, waterworn basalt, and coral. Among the gastropods, pipipi (Nerita picea) is the

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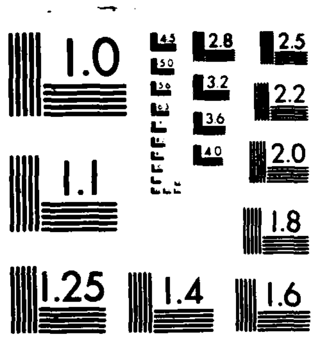

MICROCOPY RESOLUTION TEST CHART

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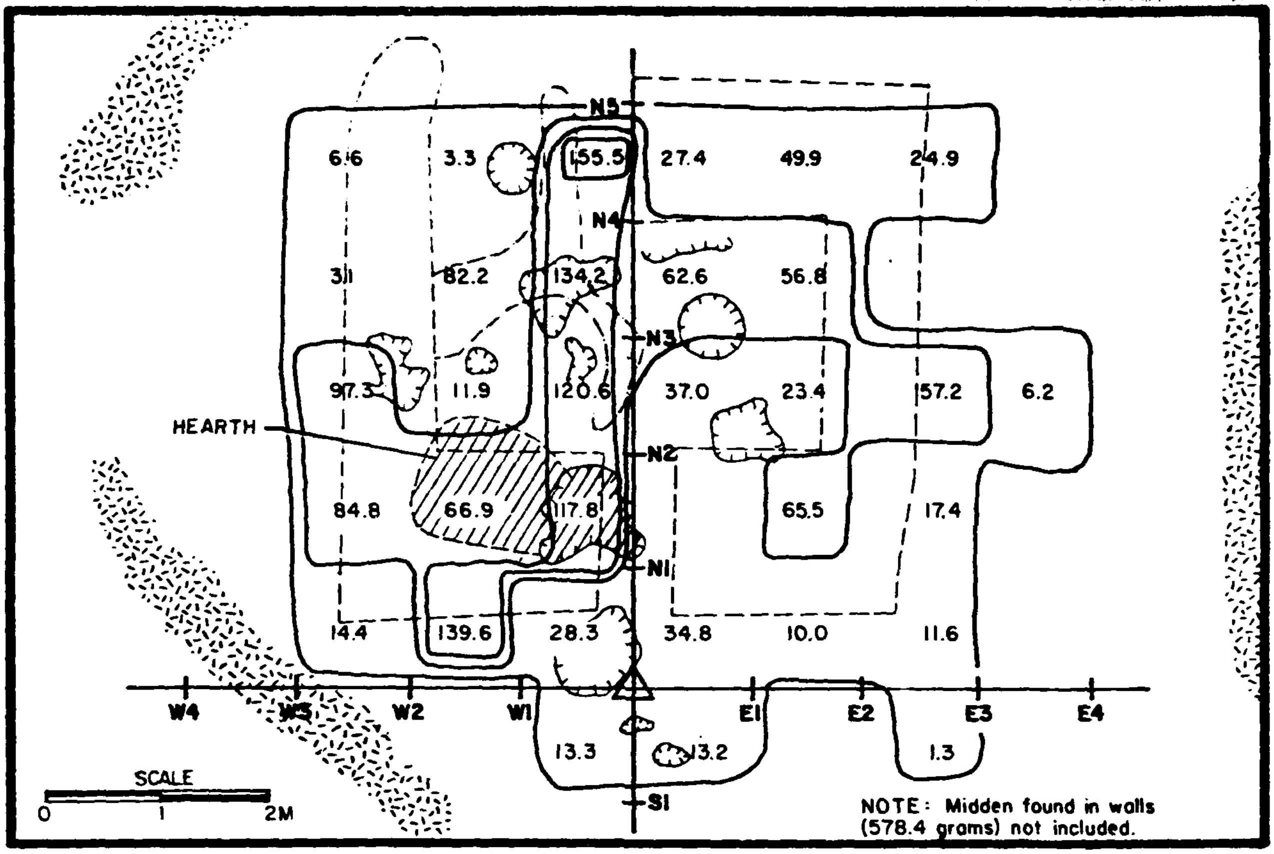


FIGURE 10 DENSITY CONTOURS(50 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM I SITE 50-80-12-2712.

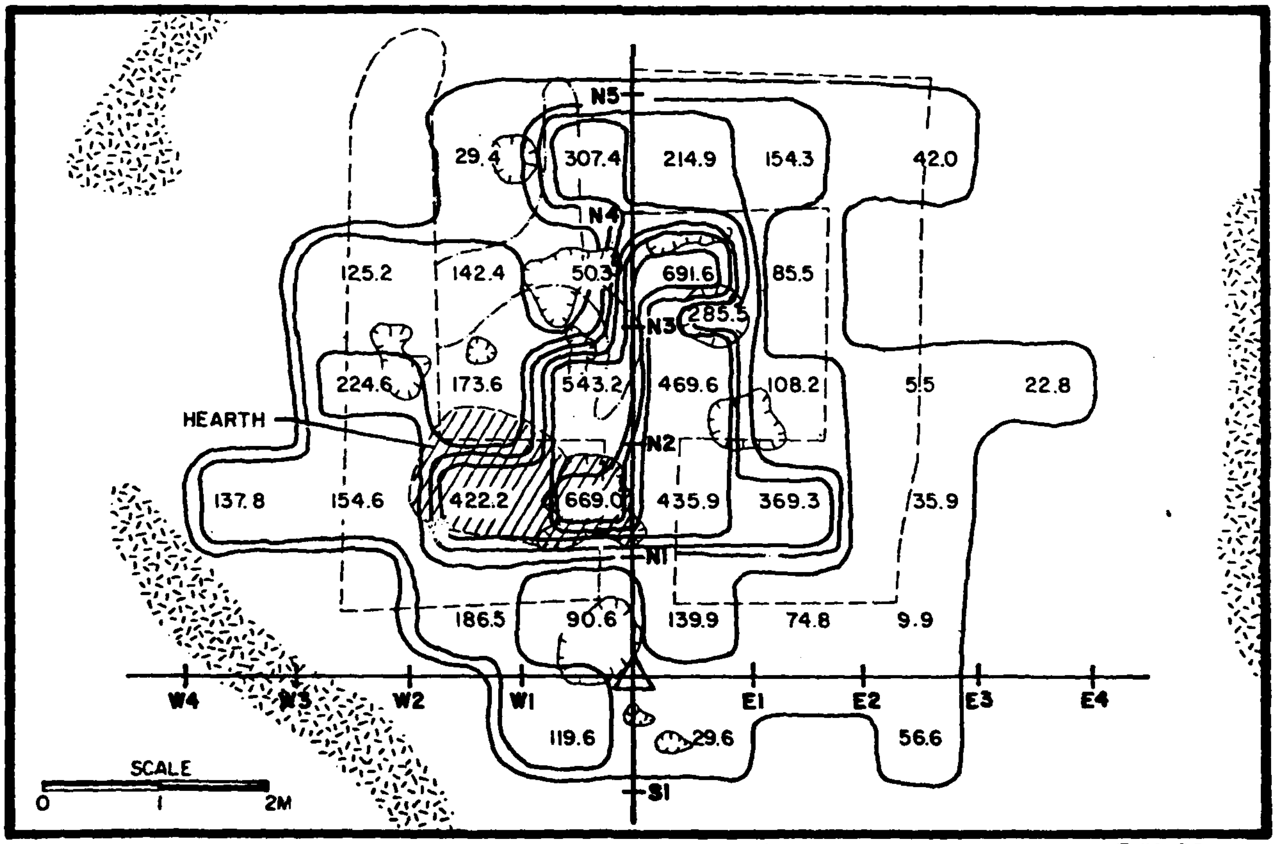


FIGURE 11 DENSITY CONTOURS(100 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM II SITE 50-80-12-2712.

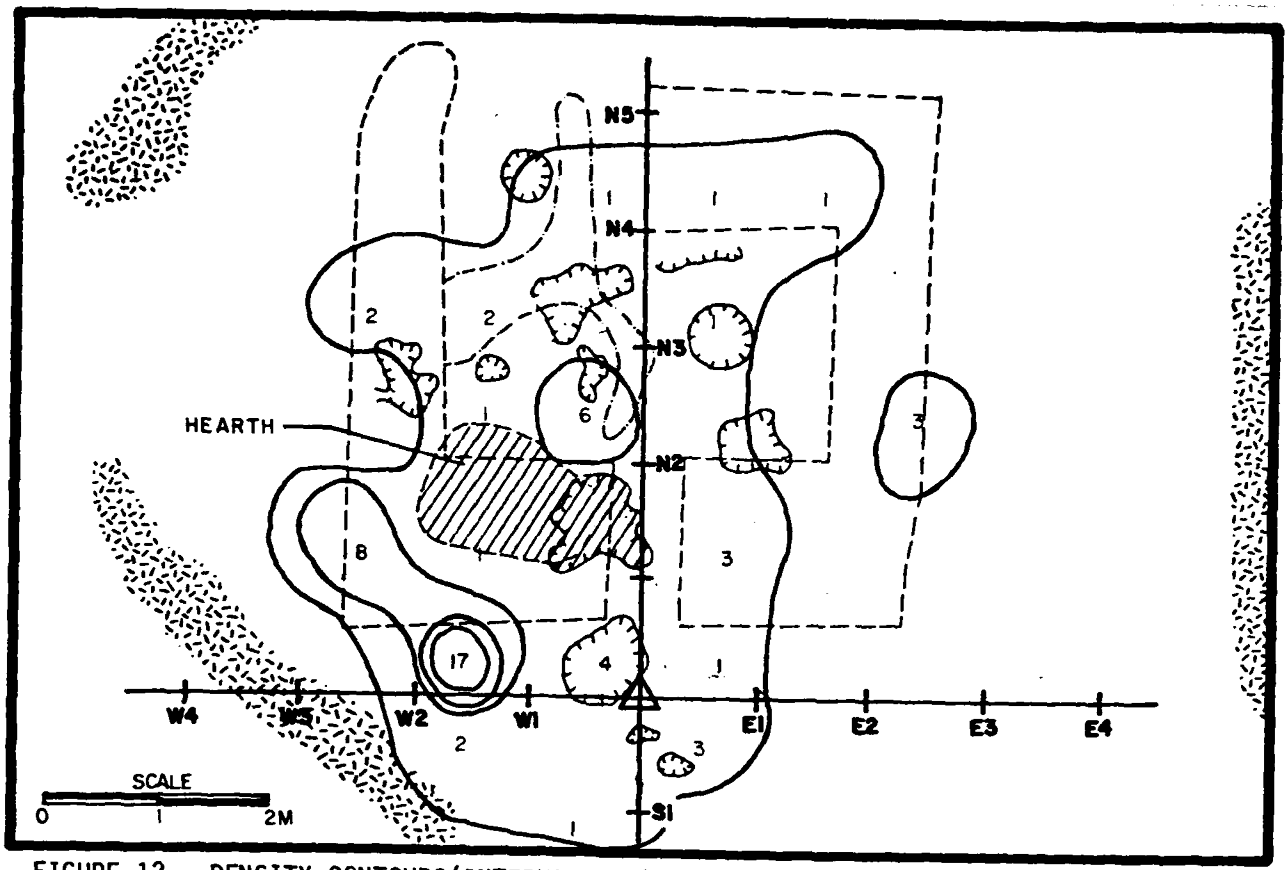


FIGURE 12 DENSITY CONTOURS(INTERVAL - 5) OF ARTIFACTS BY FREQUENCY, STRATUM I
SITE 50-80-12-2712.

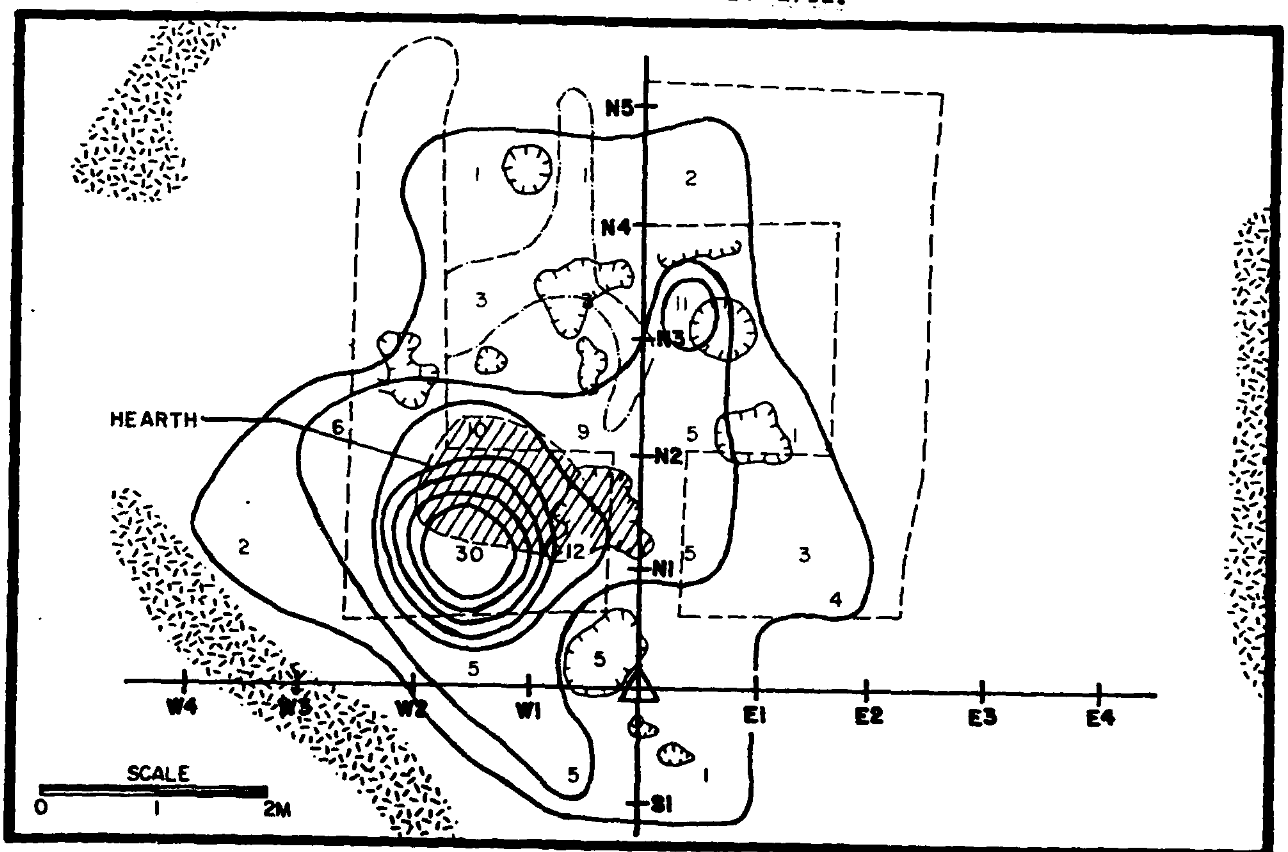


FIGURE 13 DENSITY CONTOURS(INTERVAL - 5) OF ARTIFACTS BY FREQUENCY, STRATUM II
SITE 50-80-12-2712.

prevalent. This shellfish appears to have been a major source of protein in the diet of the occupants. Other univalves, including cowrys, cones, turbo, Cerithium, periwinkles, and rock shells, were present to a lesser degree than the Nerita picea. The pelecypods were represented by Tellina, Brachidontes, Periglypta, Pinctada and Isognomon. Among this group, Isognomon and Pinctada remains can be considered detritus from the manufacture of fishhooks, as well as food refuse.

Based on this information, the sequence of activities which occurred at Site 2712 can be summarized this way:

1. Construction of a stone (reef limestone) structure and subsequent occupation of this feature.

2. Continued permanent or temporary occupation over an unknown period of time during which additions to the structure were made. Peak concentrations of midden are around the interior hearth and a refuse pit, while the highest frequency of artifacts occur adjacent to the interior hearth.

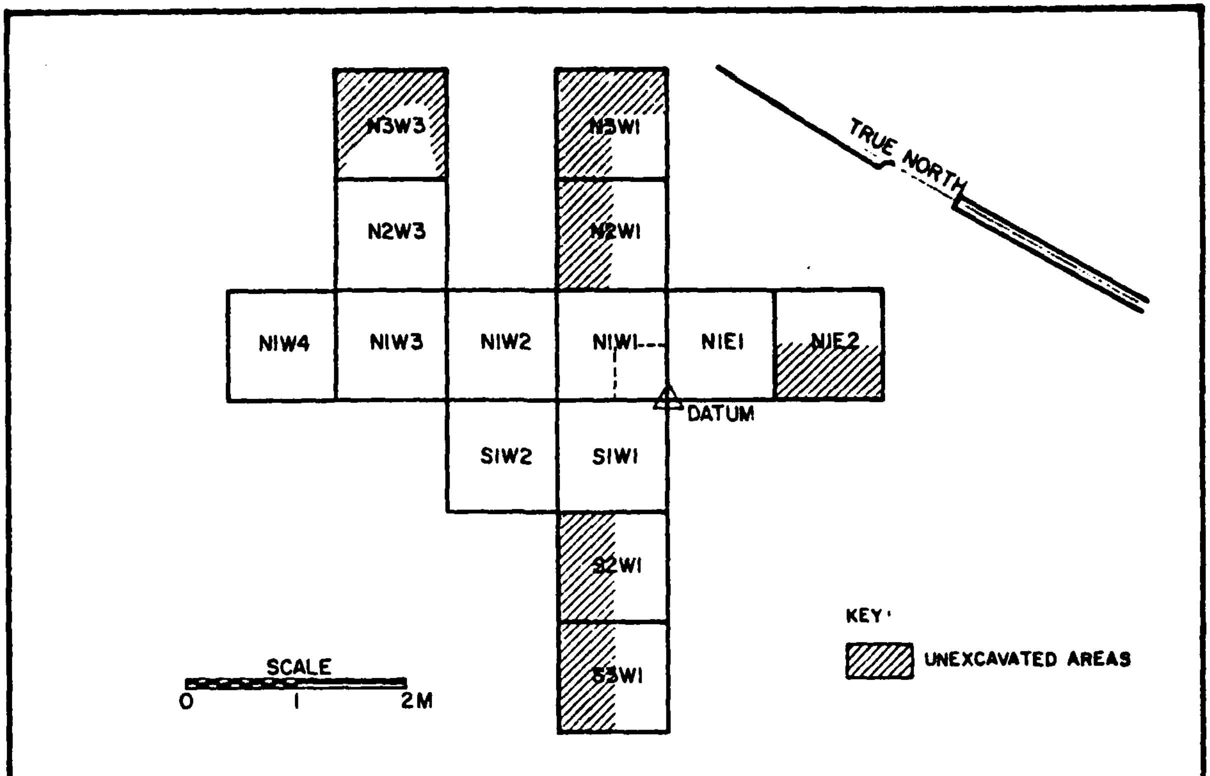
3. Abandonment of the site.

4. Recent temporary reoccupation of the site for military field exercises and contemporary modification of parts of the existing structure, followed by permanent abandonment to the present.

Site 50-80-12-2723

Description

The surface component of Site 2723 (Figure 14) is comprised of two (2) short wall segments which intersect at a 90° angle to form an "L-shape" open to the west and protected on the east by the walls. The walls are constructed of reef limestone boulders, cobbles, and



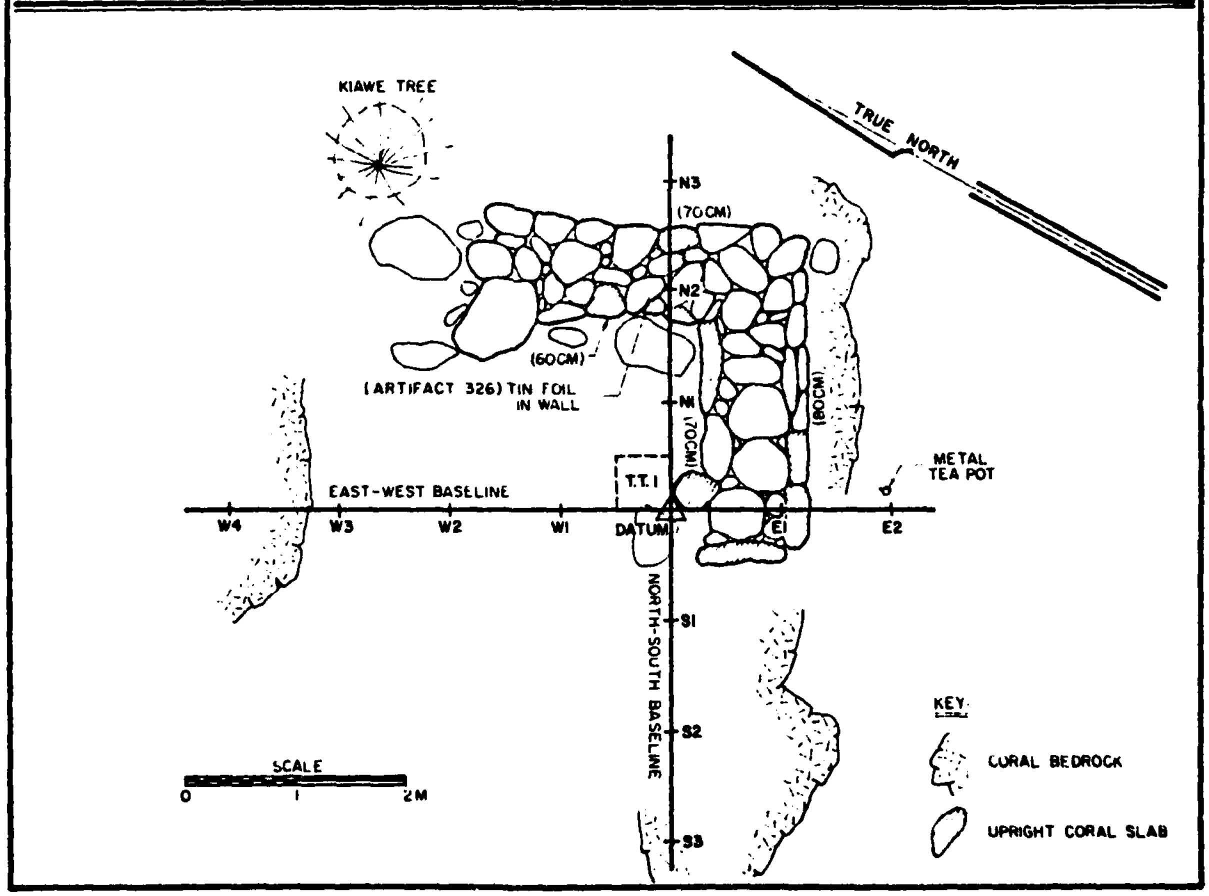


FIGURE 14 PLAN VIEW OF SITE 50-80-12-2723, SHOWING EXCAVATION GRID.

pebbles in a core filled style, utilizing two (2) parallel alignments (30 to 50 centimeters apart) of upright slab shaped boulders and stacked polygonal boulders for wall facings, and a boulder, cobble, and pebble rubble fill between to finish the wall. The walls of the structure are partially collapsed, but the foundation (lowermost) stones are less disturbed. Some are partly buried by the sediments. A 5 to 10 centimeter thick layer of forest litter covers the general area and exposed bedrock is present to the northwest and the south of the surface structure. Recent disturbances in the area include the rooting of large kiawe trees around the structure, the uprooting of one of these trees situated a few meters west of the feature, and a logged roadway situated east of the structure. A small sink (about 1 meter in diameter) located at the north end of the structure is filled with pebbles, cobbles, and boulders. The numerous sinks present in the surrounding area have either (1) wide openings (1 to 2 meters) and shallow lying sediments; or (2) narrow openings (less than 1 meter) with thin or no sediments layers.

Excavation Results

Eleven and one-half (11.5) square meters were excavated. The structural walls were sectioned by trenches to identify the stratigraphic layers present and to determine the relationship between the surface structure and the stratigraphic units. Midden density and artifact frequencies are summarized in Figures 15 through 18.

The stratigraphic units present are described from uppermost to lowest as follows:

UNIT I — Very dark brown (10 YR 2/2) matrix of loose, fine, gravelly silt loam with few cobbles and high organic content. Recent 0 and A1 horizon. Thickness ranges from 4 to 10 centimeters. Weak coarse crumb structure, very friable, very slightly sticky, non-plastic. Fine, medium and coarse roots are common. The lower boundary is abrupt and smooth. This unit

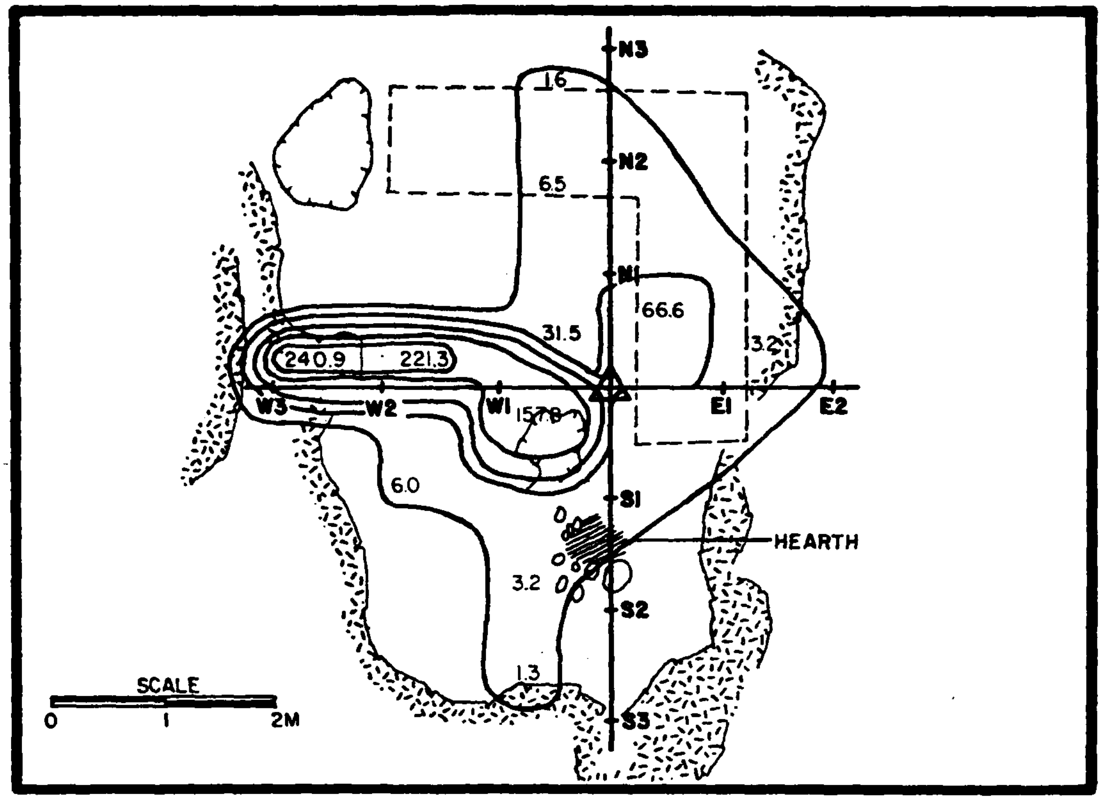


FIGURE 15 DENSITY CONTOURS (50 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM I SITE 50-80-12-2723.

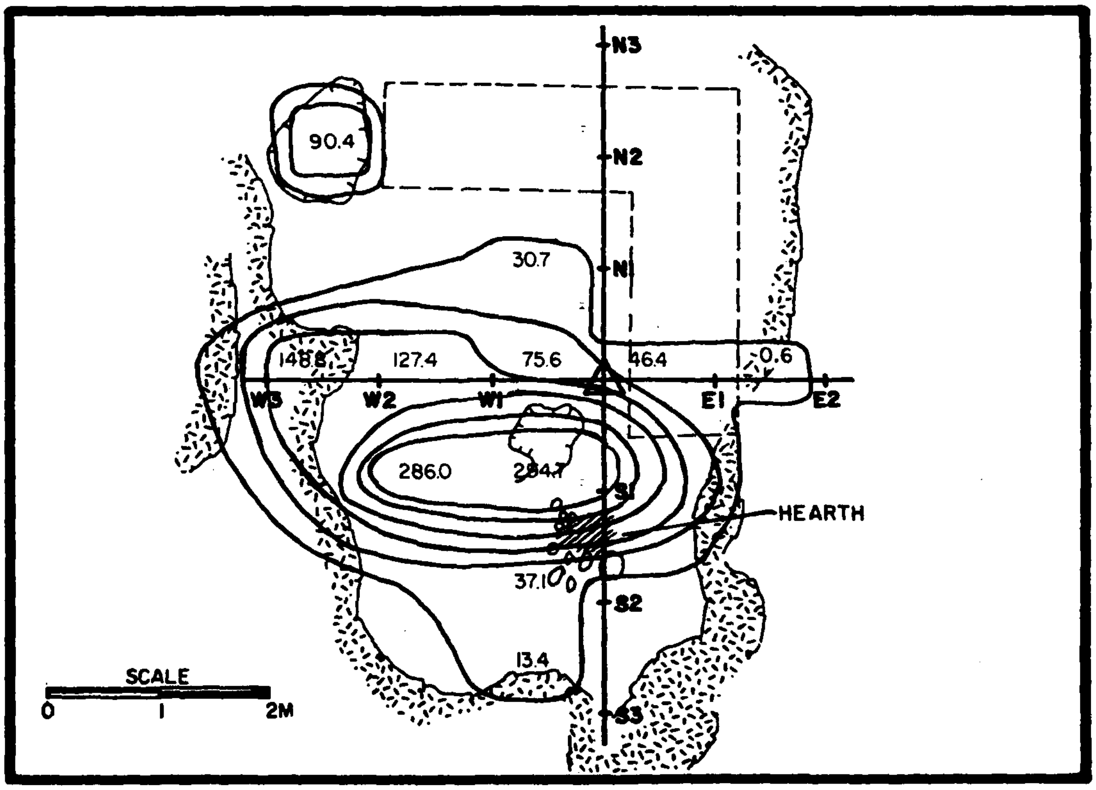


FIGURE 16 DENSITY CONTOURS (50 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM II SITE 50-80-12-2723.

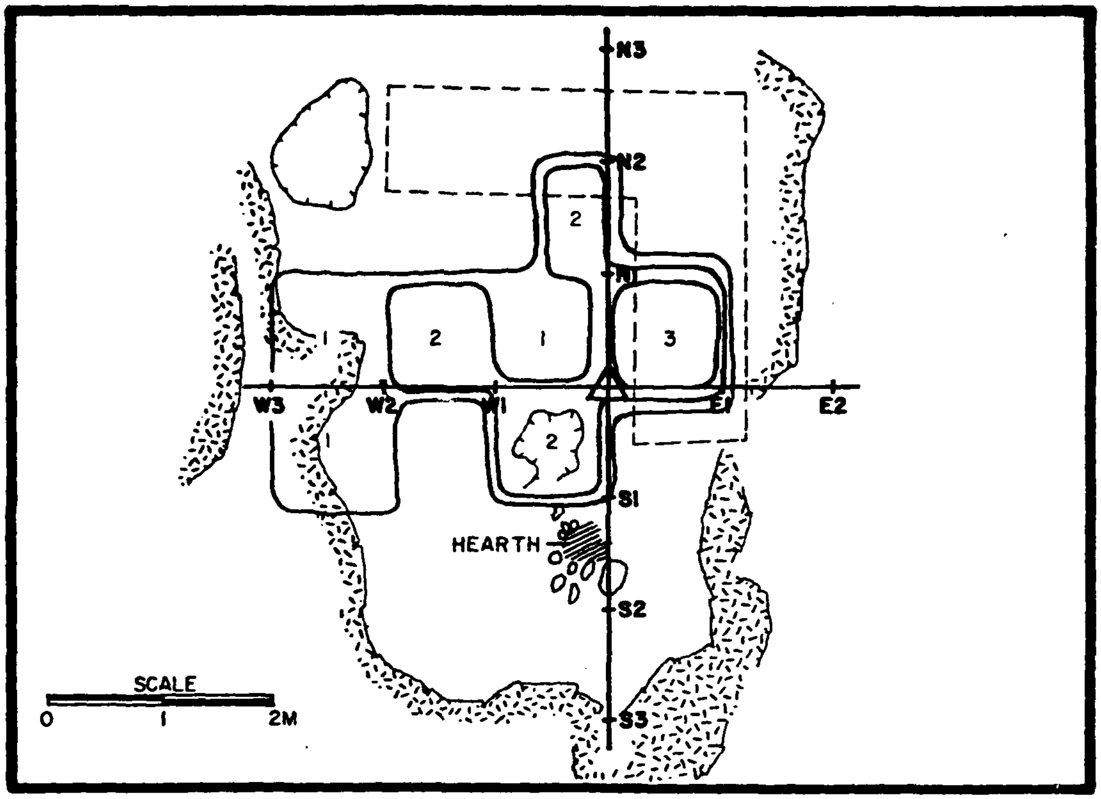


FIGURE 17 DENSITY CONTOURS(INTERVAL - 1) OF ARTIFACTS BY FREQUENCY, STRATUM I SITE 50-80-12-2723.

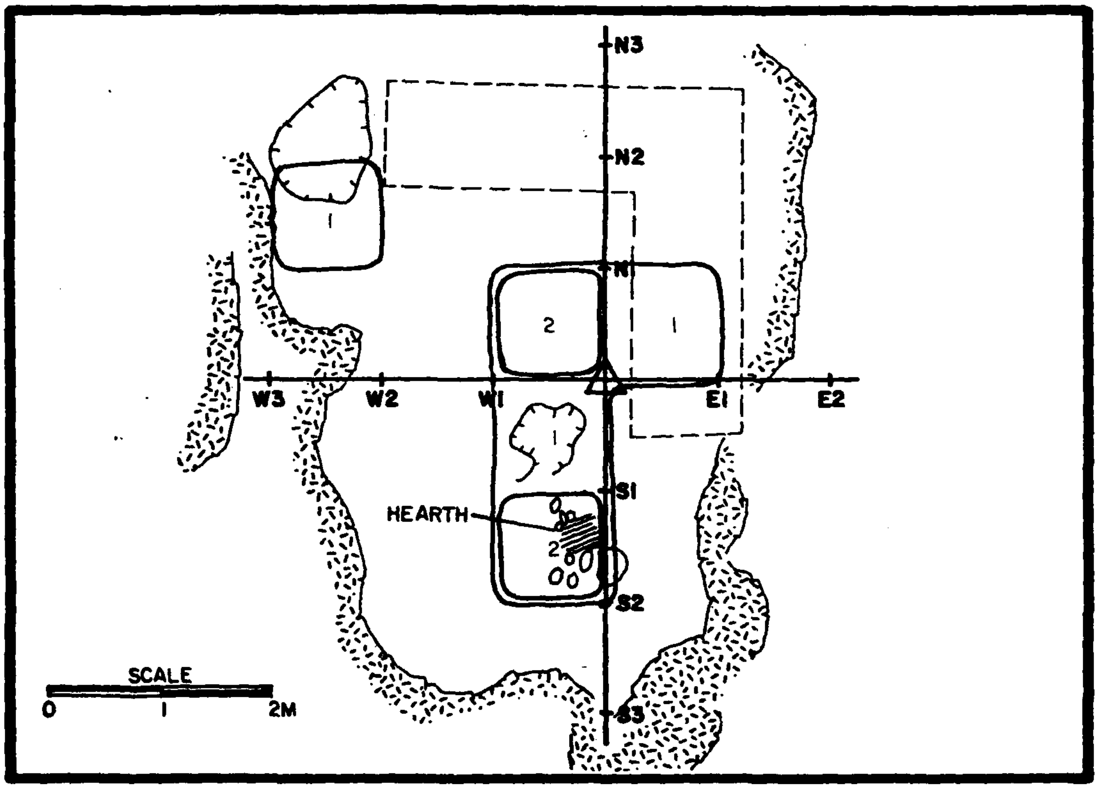


FIGURE 18 DENSITY CONTOURS(INTERVAL - 1) OF ARTIFACTS BY FREQUENCY, STRATUM II SITE 50-80-12-2723.

contained shellfish, urchin and bone midden and a few artifacts.

UNIT II Very dark to dark greyish brown (10 YR 3.5/2, moist; 10 YR 5/2, dry) matrix of loosely compacted gravelly cobbly silt loam. This A3 horizon contained prehistoric (?) artifacts and organic midden and subsurface features (nonportable artifacts). Thickness ranges from 9 to 14 centimeters and exceeds 14 centimeters in some shallow pockets in bedrock. The structure is coarse to very coarse crumb; friable, slightly sticky, nonplastic. Fine and medium roots are common, with few coarse roots. The lower boundary is clear and wavy.

UNIT III White (10 YR 8/2), very fine, compact, gravelly cobbly silt loam. The C horizon is discontinuous in pockets of bedrock and is structureless, massive, soft, friable, nonsticky, and nonplastic. Cultural material was restricted to the uppermost 2 to 3 centimeters where present.

UNIT IV Reef limestone bedrock, irregular surface pitted by solution sinks of varying size and depth.

Excavation of Unit I revealed the presence of cultural midden and artifacts associated with historic activity. Midden consisted of shellfish, sea urchin, and bone material; the artifacts uncovered include a metal teapot and tinfoil fragments and coral files (including fragments), a cut shell fragment, and a one-piece shell fishhook. The prehistoric (?) artifacts (files, cut shell and fishhook) are probably not contemporaneous with Unit I since they were located in the south wall of the surface structure where effects of mixing and settling are most pronounced. No nonportable artifacts were present in Stratum I. The historic material found in the general area of the site evidences recent activity, and the presence of midden in the 0 and A1 horizon (Stratum I) indicates that some of this activity took place at Site 2723.

Unit II is a cultural (A3) horizon containing midden, including shellfish and sea urchin remains, bone and charcoal, and prehistoric (?) artifacts comprised of coral files and fragments, a possible limestone flake awl, and worked Isognomon shell pieces. Generally, the density of midden and portable artifacts in Site 2723 is low in Stratum II. No artifacts of historic manufacture were found in association with Stratum II.

A small (13-centimeter diameter) deposit of charcoal-stained dirt in Stratum II contains a few fragments of charcoal but no discernible ash deposits. It is located at the west extreme of the site in S2W1. This probable hearth is 8.5 centimeters thick extending from 11 centimeters below surface to 19.5 centimeters below surface. This maximum depth coincides with the maximum depth of Stratum II here. At 6 centimeters below surface (in S2W1) where Stratum II was first encountered, a high percentage of ash was evident in the matrix of Stratum II and 10 coral cobbles and small boulders were embedded in the Stratum II layer. All these rocks display charcoal-stained and heat-altered undersurfaces. No other subsurface features are present in the excavations.

The horizontal extent of Stratum II is confined on the south and east by the structure walls (it does not extend outside of the walls) and on the north and west by a more elevated area of partially exposed bedrock where only Units I and III are present. Midden in Unit II is densest in the partially enclosed area nearest the walls. Midden density decreases towards the west, away from the structure.

The filled sink (situated at the west end of the north wall) contained three sediment layers which correlate well (except in color) with the sediment layers in the rest of the site. Layer I is comprised of boulder and cobble fill mixed with the recent 0 and A1 horizons. Midden content is virtually nonexistent. Layer II consists of a greater amount of dirt than Layer I and contains cultural refuse. Layer III is a culturally sterile layer of reddish color (7.5 YR 4/4) with a high percentage of gravel and cobbles and correlates with the fine silt (10 YR 6/4) of Stratum III on the surface outside the sink.

The events occurring at 2723 can be summarized sequentially as follows:

1. Contemporaneous occupation and construction of a formal "L-shaped" dry masonry structure.

2. Continued frequent (temporary) or permanent occupation while Unit II was formed and the cultural materials deposited. Concentrations of midden artifacts are situated near the south extreme of the site adjacent to the small poorly defined hearth.

3. Abandonment of the site for an unknown period of time.

4. "Modern" usage of the area, for kiawe logging operations, cattle grazing, and for military activities while the recent A1 horizon (Unit I) was formed and cultural materials deposited. Peak midden concentration in this unit may be derived from mixing with Stratum II because of the thin loose nature of Unit I and Unit II.

5. Continuation of logging operations in the area.

Site 50-80-12-2730

Description

Site 2730 (Figure 19), a rectangular-shaped remnant of a four-sided enclosure, is formed by four walls constructed of reef limestone boulders and cobbles. The walls are core fill style, utilizing upright slab-shaped boulders for the foundation stones along the interior wall faces and the exterior of the west wall where a sharply defined entrance truncates this wall. The exterior faces of the remaining three walls are in a state of collapse, appearing as low linear mounds of rubble beneath which a remnant of the previous alignment, now discontinuous, is discernible.

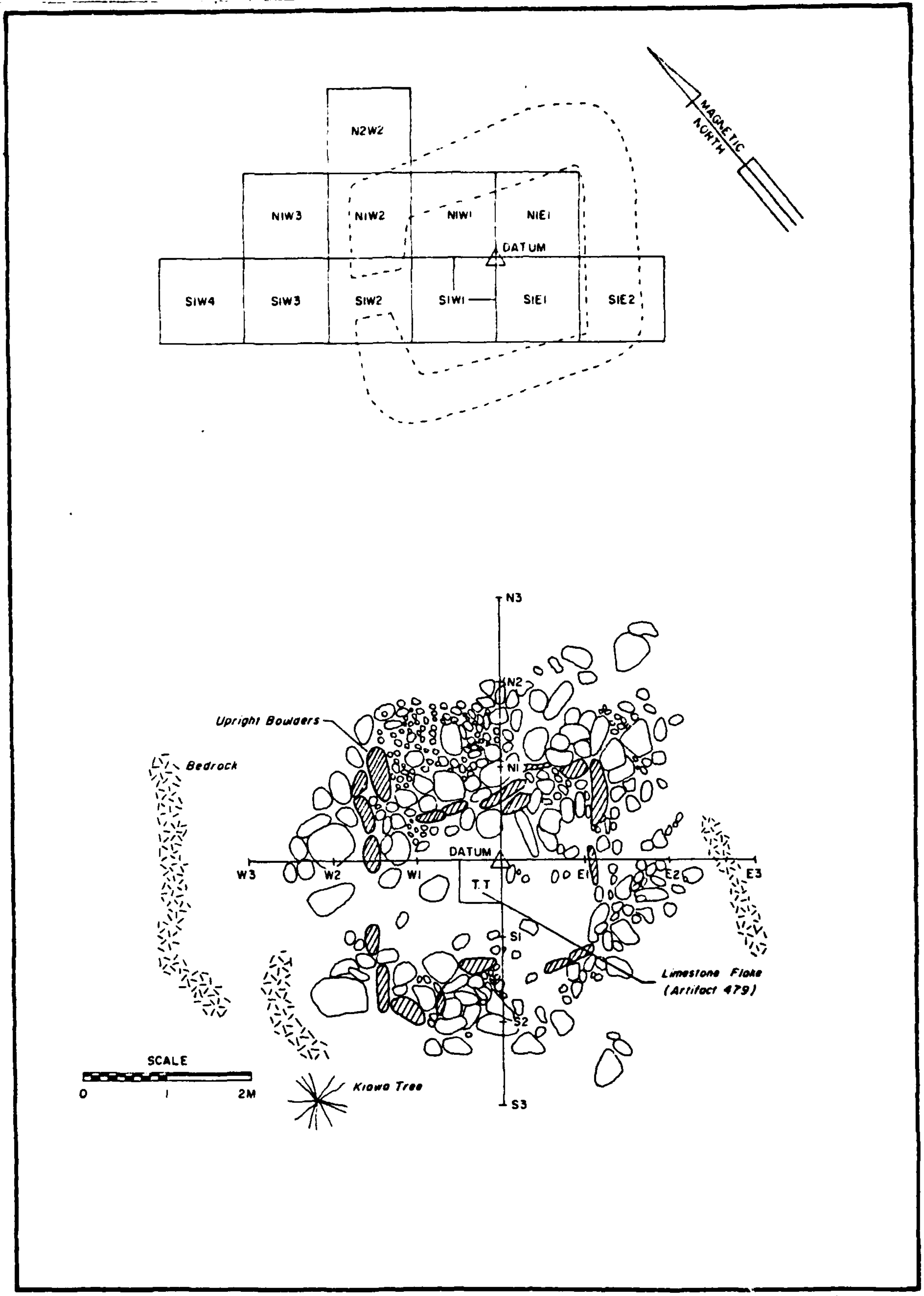


FIGURE 19 PLAN VIEW OF SITE 50-80-12-2730, SHOWING EXCAVATION GRID.

The interior area defined by the enclosing walls measures 1.5 meters north to south by 2.75 meters east to west. Heights of the wall remnants range from 20 centimeters to 50 centimeters above the surrounding ground surface.

An entranceway is situated in the west wall (as mentioned above), so the enclosure opens to the northwest. No discernible features are present inside or outside the site, and the area surrounding the site is disturbed by bulldozing and logging activities. Any sinks present in the immediate vicinity of Site 2730 have been filled and completely obscured.

Excavation Results

Excavations were conducted in the interior area of Site 2730 and in the area outside of the entrance to the west of the site where artifact and midden densities were greatest (Figures 20 through 23). The west and east walls of the str cture were sectioned to determine the relationship between the structure and the stratigraphic units present. A total of 11 square meters were excavated.

The four (4) stratigraphic units present all occur throughout the excavations. They are described next from uppermost to lowest:

UNIT I — Very dark grey (10 YR 3/1 moist) matrix of fine gravelly and cobbly silt loam. Recent 0 and A1 horizon. Thickness ranges from 2 to 5 centimeters in open areas to 15 centimeters thick in interstices of surface boulder piles and structure walls. This unit is culturally sterile except for a few shellfish remains in walls and the lower boundary is clear and wavy.

UNIT II — Brown (7.5 YR 4/4, moist; 10 YR 4/3, moist) matrix of fine gravelly, cobbly silt loam; A3 horizon. Thickness ranges from 4 to 7 centimeters, with two hearth deposits exceeding 17 centimeters. This unit contains cultural material, including midden and

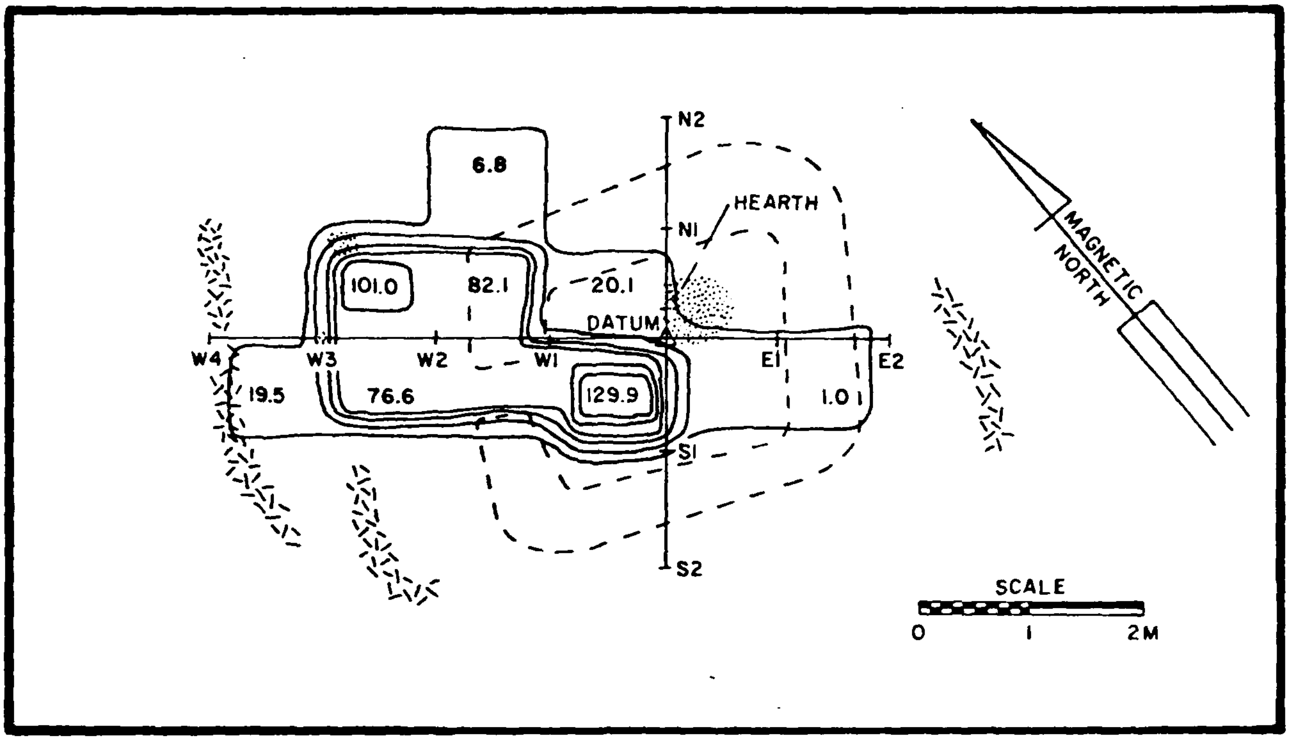


FIGURE 20 DENSITY CONTOURS (25 GRAM INTERVAL) OF MIDDEN WEIGHT, STRATUM I SITE 50-80-12- 2730.

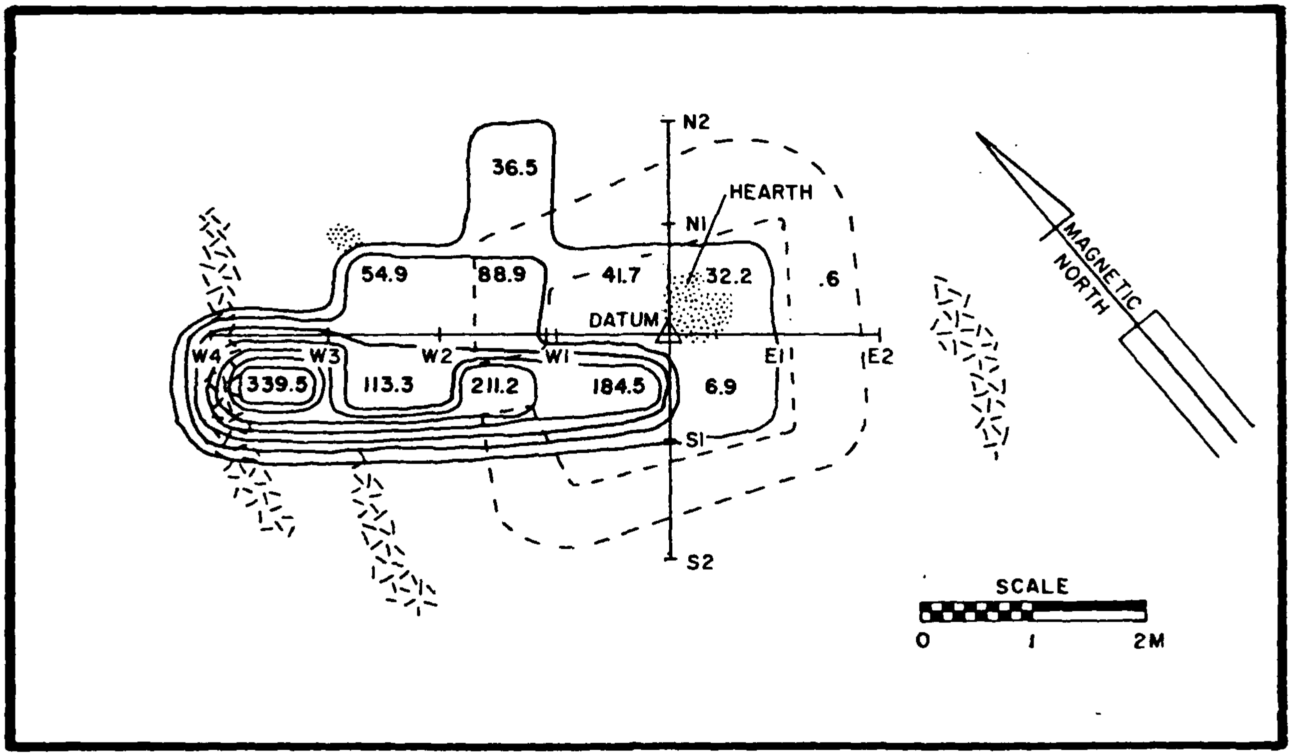


FIGURE 21 DENSITY CONTOURS (50 GRAM INTERVAL) OF MIDDEN WEIGHT, STRATUM II SITE 50-80-12- 2730.

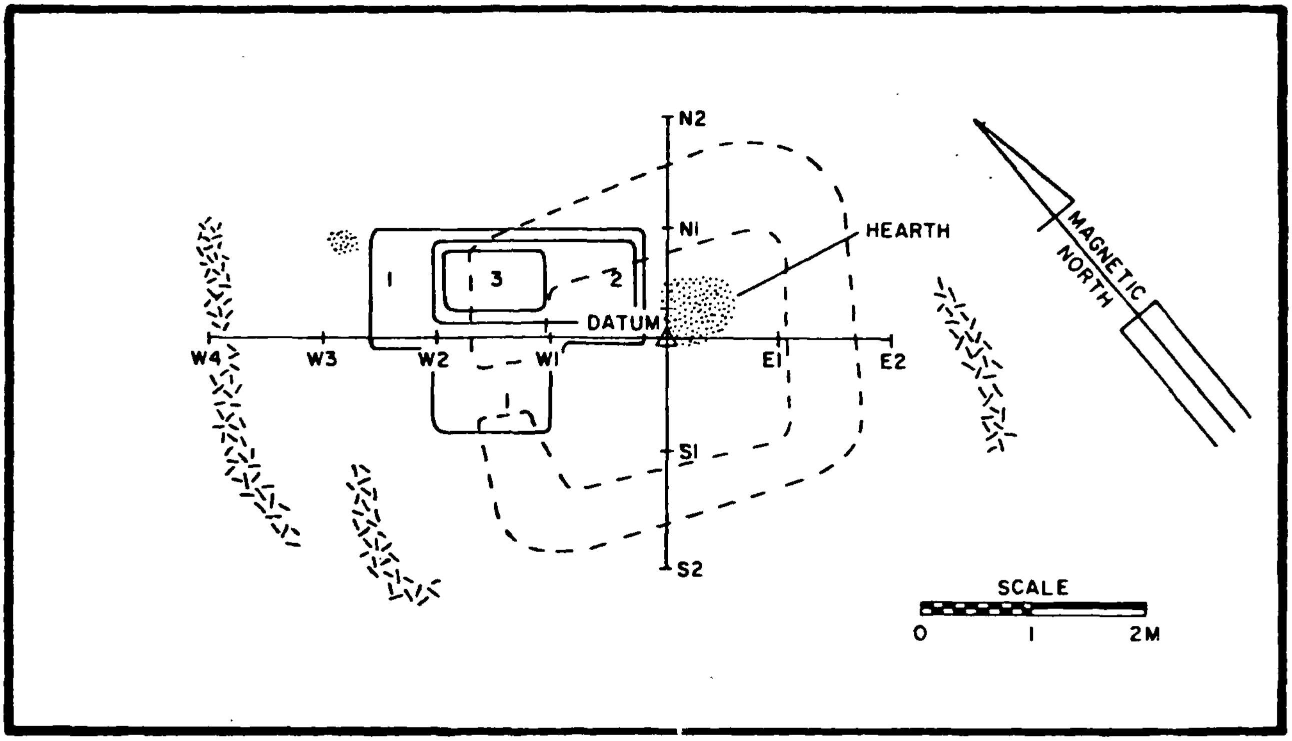


FIGURE 22 DENSITY CONTOURS (INTERVAL-1)OF ARTIFACTS BY FREQUENCY, STRATUM I, SITE 50-80-12- 2730.

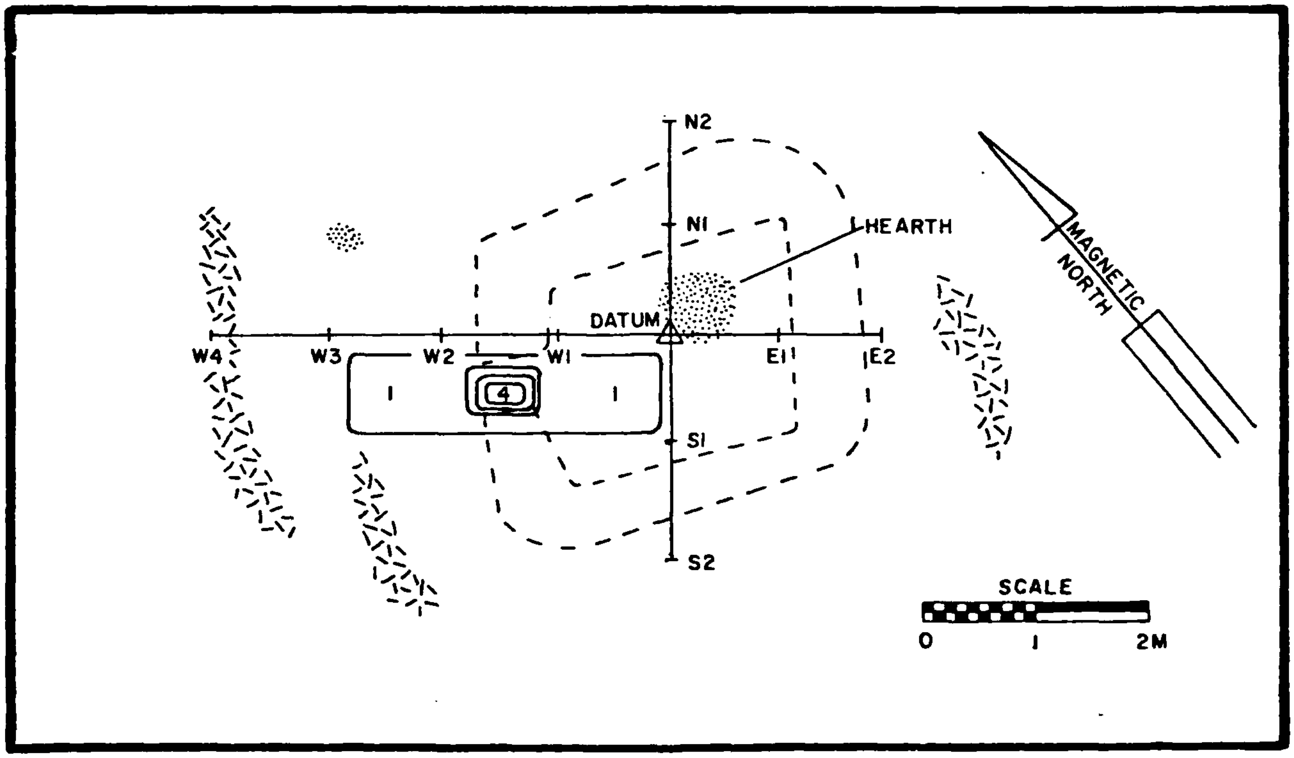


FIGURE 23 DENSITY CONTOURS (INTERVAL-1) OF ARTIFACTS BY FREQUENCY, STRATUM II SITE 50-80-12- 2730.

portable and nonportable artifacts. The lower boundary is clear and wavy.

UNIT III Very pale brown (10 YR 7/3, moist) very fine gravelly silt loam with few cobbles; C-horizon. No cultural remains were found. The lower boundary is clear and wavy.

UNIT IV Reef limestone bedrock.

The occupation sequence interpreted from soil profile data is contained in a single continuous unit (the A3 horizon). Actual use of the site may have been on a short term permanent or frequent, temporary, basis.

The interior of the feature was excavated first and, although midden and artifacts were sparse, a limestone cobble and boulder-lined hearth was discovered in the cultural unit situated in the northeast corner (i.e., the left rear area when facing the interior from the entranceway).

The interior hearth (above), which does not taper downward, is 60 to 80 centimeters in diameter, has a rock-lined perimeter, and is intrusive through Stratum III to the bedrock surface at a maximum depth of 22 to 25 centimeters below surface. The bedrock surface at the hearth bottom was blackened by charcoal staining and heat alteration as were the limestone cobble fragments and cobbles found within the hearth deposit in the lowest 10-centimeter level. This hearth was first discernible at 2 centimeters below the surface of Stratum II and contained almost no midden, no concentrated ash layers, and less than 10 grams of charcoal. (One hundred percent of the charcoal was collected for analysis.) The excavation trenches were then extended to the west, through the west wall and entranceway and outside the enclosure.

Midden density of Stratum II in this area of the site rose considerably and consisted of large quantities of pipipi (*Nerita picea*) and *Brachidontes* (90% of the midden) with some *Conus*, *Cypraea*, Hipponix, kukui nut shell, sea urchin, Tellina, Periglypta, and Drupa, and bone. Midden present in Stratum I is probably a result of upward reworking of the lower stratum. Midden is also present in the uppermost few centimeters of Stratum III.

Artifacts recovered consist of six (6) coral files (including fragments), a one-piece shell fishhook fragment, and a composite fishhook point fragment of bone. All these specimens were found at the western edge of the site outside the entrance or intermixed with the buried foundation stones of the west wall.

A 5-centimeter thick deposit of dark grey charcoal flecked ash in Stratum II was observed in the northeast quadrant of S1W3, situated one and one-half (1.5) meters outside and to the west of the entrance. Midden and artifact densities were greatest in this area. The ash layer was not a well-defined feature.

The area surrounding the site was very disturbed. However, about 20 meters to the north of Site 2730 an area of numerous solution sinks remaines relatively undisturbed.

Site 50-80-12-2731

Description

Site 2731 is a circular-shaped enclosure with an average interior diameter of 2.5 meters (Figure 24). The structure consists of a continuous limestone boulder and cobble wall, broken only by an entranceway in the north side of the wall. The wall has collapsed and the remaining foundation stones are buried under a sloping rubble pile. A few upright boulder slabs are present along the western side of the enclosure. The south side of the enclosure wall appears to have been rebuilt relatively recently. It is made of roughly stacked boulders, while the remaining sections of the wall are constructed in the core fill style. The entranceway of the enclosure is well defined and is bordered on west by a single upright and on the east by stacked boulders.

Bulldozing has occurred in the area immediately surrounding Site 2731 especially to the north and east (toward Sites 2730 and 2732,

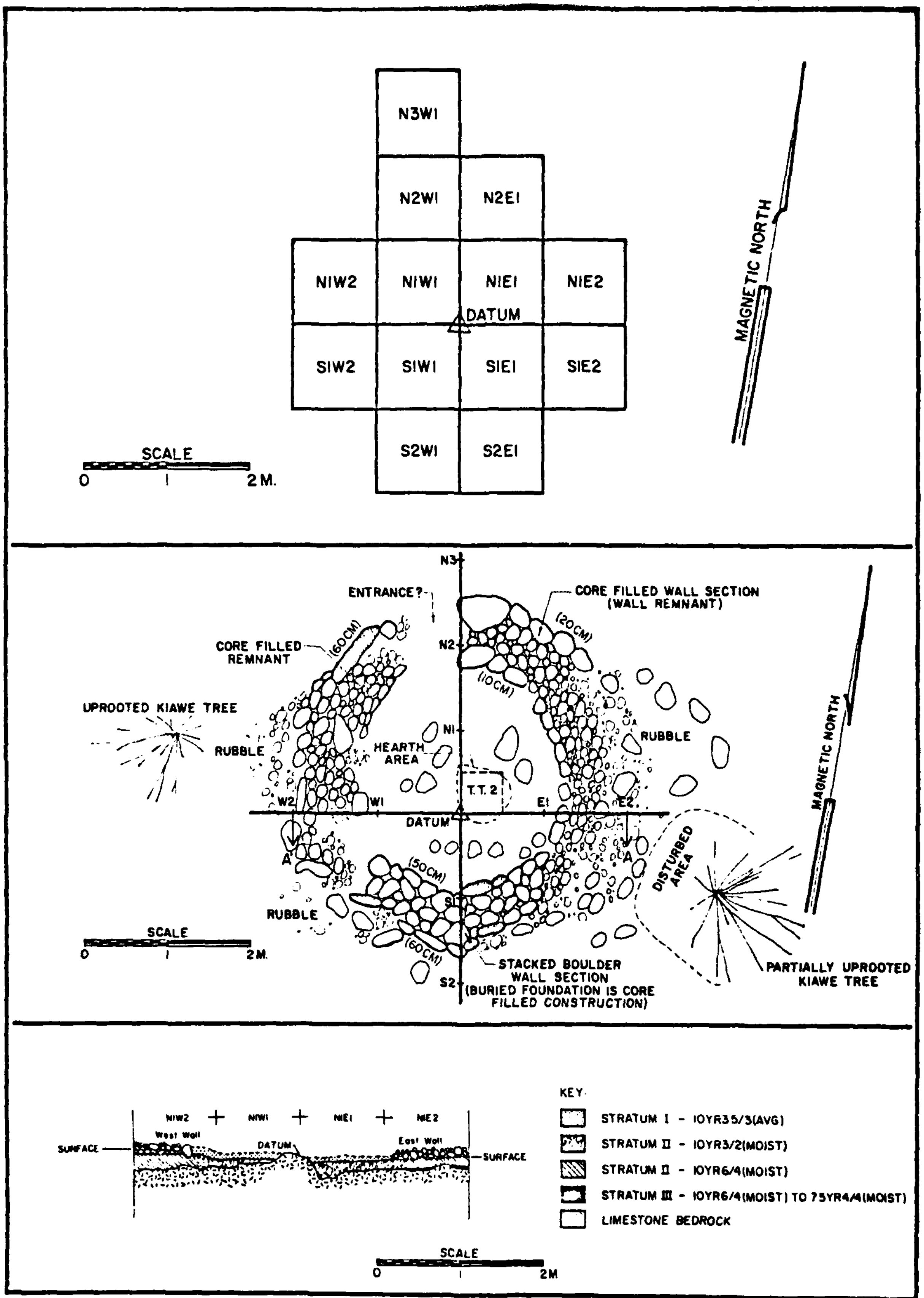


FIGURE 24 PLAN VIEW OF SITE 50-80-12-2731, SHOWING EXCAVATION GRID AND CROSS SECTION.

respectively). To the west and south, numerous standing and partially uprooted kiawe trees display chain saw cuts from previous logging activities. Any sinks situated nearby are completely obscured by the disturbances except those mentioned previously. (See the description of Site 50-80-12-2730.)

Excavation Results

The first trenches in Site 2731 were excavated in the structure interior and were subsequently enlarged through the entranceway toward the north and through the east, south, and west structural walls. A total of 13 square meters was excavated. Midden density and artifact frequency are summarized in Figures 25 through 28.

The four stratified layers present in the excavations are described next from uppermost to lowest:

UNIT I (10 YR 3.5/3 average) matrix of fine gravelly cobbly silt loam, with an overburden of decomposing forest litter (recent A1 and 0 horizons, respectively). Fine and medium roots are common. This unit ranges from 2 to 5 centimeters thick, with increased thickness in the interstices of wall boulders. Disturbed areas have some cultural remains, probably derived from the upward reworking of Unit II. The lower boundary is clear and wavy.

UNIT II (10 YR 3/2, moist) matrix of fine, gravelly and cobbly silt loam (A3 horizon), with fine and medium roots common. Cultural remains were found within the enclosure interior. The matrix of this unit changes to 10 YR 4/3, fine, very gravelly, very cobbly silt loam under walls and midden and artifact densities decrease considerably. Thickness of the unit ranges from less than 5 centimeters to almost 20

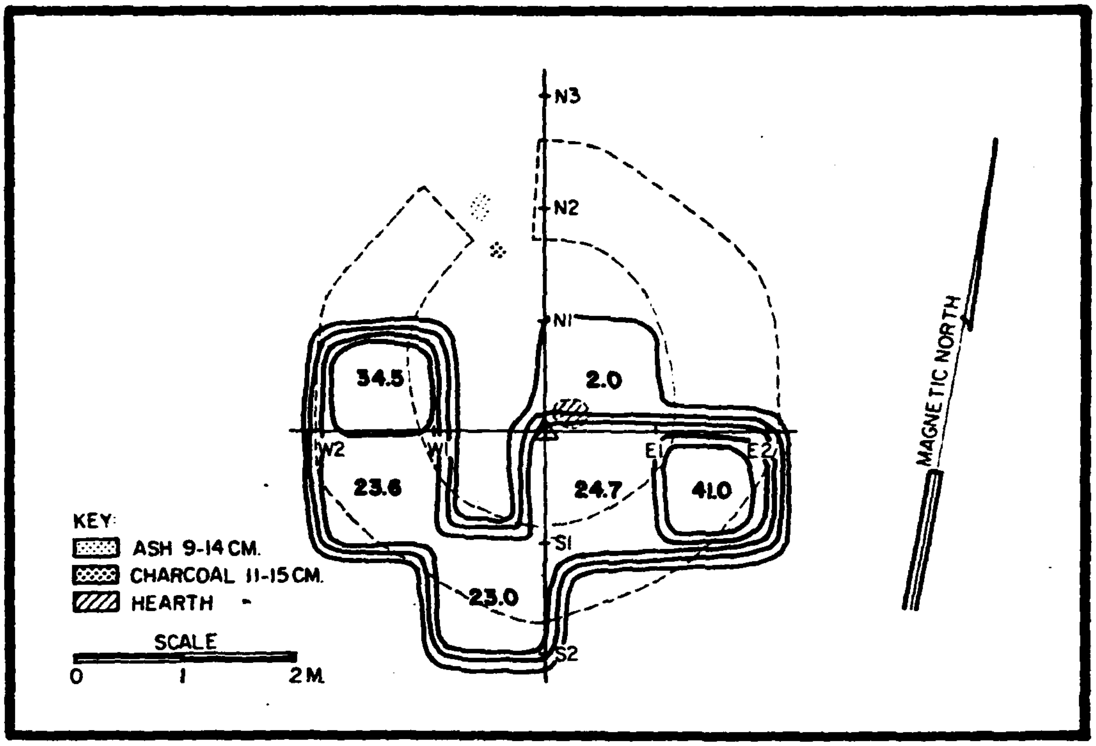


FIGURE 25 DENSITY CONTOURS (10 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM I
SITE 50-80-12- 2731

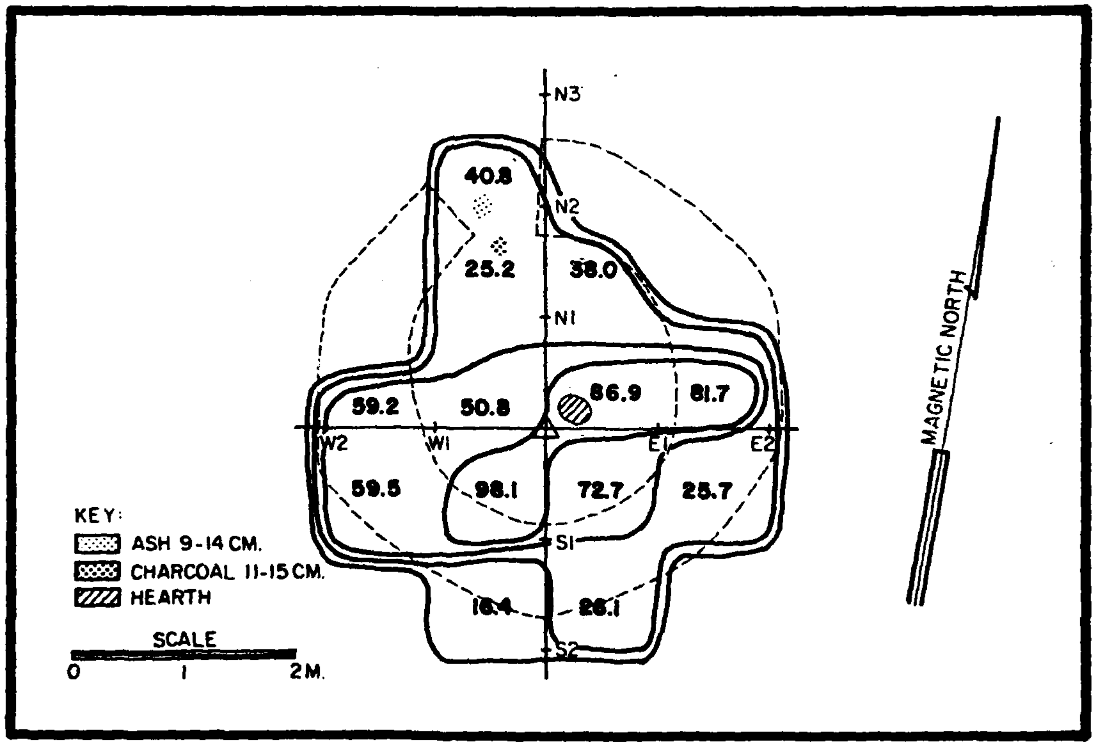


FIGURE 26 DENSITY CONTOURS (25 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM II
SITE 50-80-12- 2731

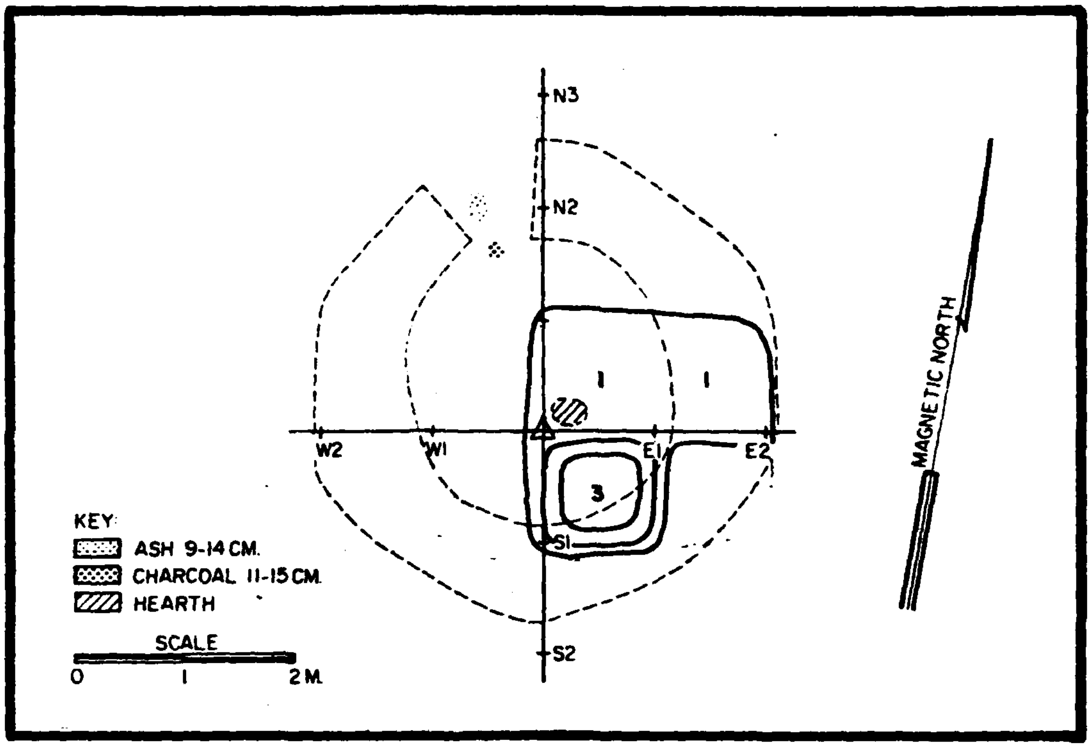


FIGURE 27 DENSITY CONTOURS(INTERVAL - 1) OF ARTIFACTS BY FREQUENCY, STRATUM I SITE 50-80-12-2731.

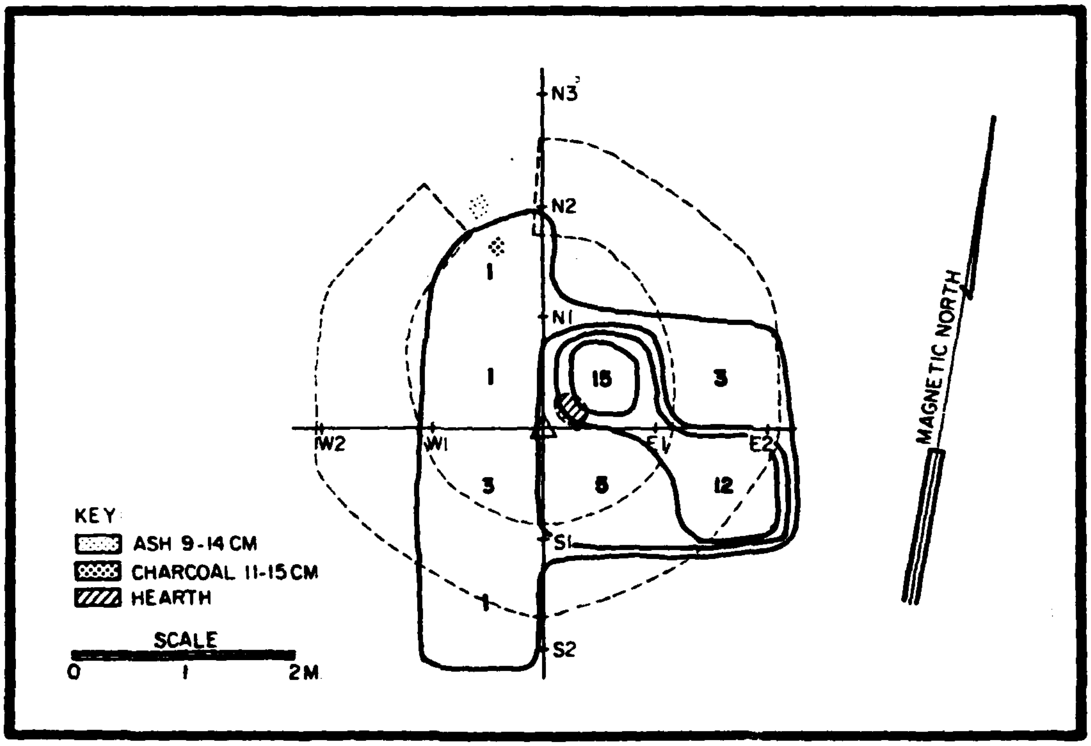


FIGURE 28 DENSITY CONTOURS(INTERVAL - 5) OF ARTIFACTS BY FREQUENCY, STRATUM II SITE 50-80-12-2731.

centimeters and the boundary is clear and wavy. This unit interfaces with Stratum IV.

UNIT III (7.5 YR 4/4, 10 YR 6/4, moist) fine gravelly, cobbly silt loam matrix with slab boulders derived from bedrock substratum. Mixing of sediments by kiawe tree root mixing is common. This unit is present under the structure wall foundations but not present in the enclosure interior. It is a culturally sterile C-horizon.

UNIT IV This unit is reef limestone bedrock with an undulating surface, pocketed by shallow solution pits. Parts of this unit extend above the surface of the sediment layers.

Excavations in the interior defined a hearth in the central rear area associated with Stratum II. This hearth was defined by the charcoal-stained color of the deposit and the charcoal flecks contained in it (A sample was collected for analysis). It is a small feature about 6 to 10 centimeters thick and contacts the bedrock substratum at 19 centimeters below surface and is from 34 to 60 centimeters in diameter.

Midden in Stratum II of Site 2731 consists of shellfish remains (sea urchin and Nerita picea are the most prevalent, with Tellina and Isognomon persistent but less numerous throughout the midden), fish bone, mammal bone, some porites coral fragments, and charcoal. This material is distributed in and around the hearth and the structure's interior.

Artifacts, as well as midden were distributed mainly around the hearth in the site interior. The artifact assemblage from the excavations consists of eight (8) coral abrading tools (including fragments), seven (7) fishhooks (including fragments) of shell and bone, cut shell and bone fragments, a shell knife or scraper, a shell columella drill, two (2) fragments of hematite and four (4) pieces of basaltic glass.

Excavation of the trenches through the wall to the east, south, and west revealed that the surface structure is contemporaneous with the Stratum II cultural layer and that the structural wall defines the horizontal limit of this stratigraphic cultural unit. Trenches excavated through the entranceway showed a dramatic decrease in midden and artifact density - - - very sparse evidence of human activity outside the structure.

The sequence of events occurring at Site 2731 is interpreted from soil profile data showing a single stratified cultural unit contemporaneous with the surface structure. Construction of the enclosure and reworking of Unit III in the enclosure interior preceded the deposition of the bulk of Unit II. Deposition of Unit II and the inclusion of refuse and artifacts continued for an unknown duration of time and may have been on a permanent or frequent, but temporary, basis. Then the site was abandoned. Although recent activities are evidenced in the area surrounding Site 2731, no concrete evidence of historic use of the site was found in Unit I.

Site 50-80-12-2732

Description

Site 2732 (Figure 29) is a partial enclosure ("U-shaped") formed by three relatively large walls (maximum 90 centimeters high by 150 centimeters wide) constructed of stacked reef limestone boulders and cobbles on exposed bedrock. The structure opens toward the southwest, where large areas of bedrock are exposed. The general area to the south and west of the site has been previously disturbed by bulldozing and logging activities. To the north and east is a wide area where solution sinks are abundant.

Excavation Results

Dismantling of the structure did not reveal any artifacts or midden. The west wall and part of the north wall of the structure

SAVE FOR FIGURE 29:
PLAN VIEW OF SITE 50-80-12-2732
SHOWING EXCAVATION GRID

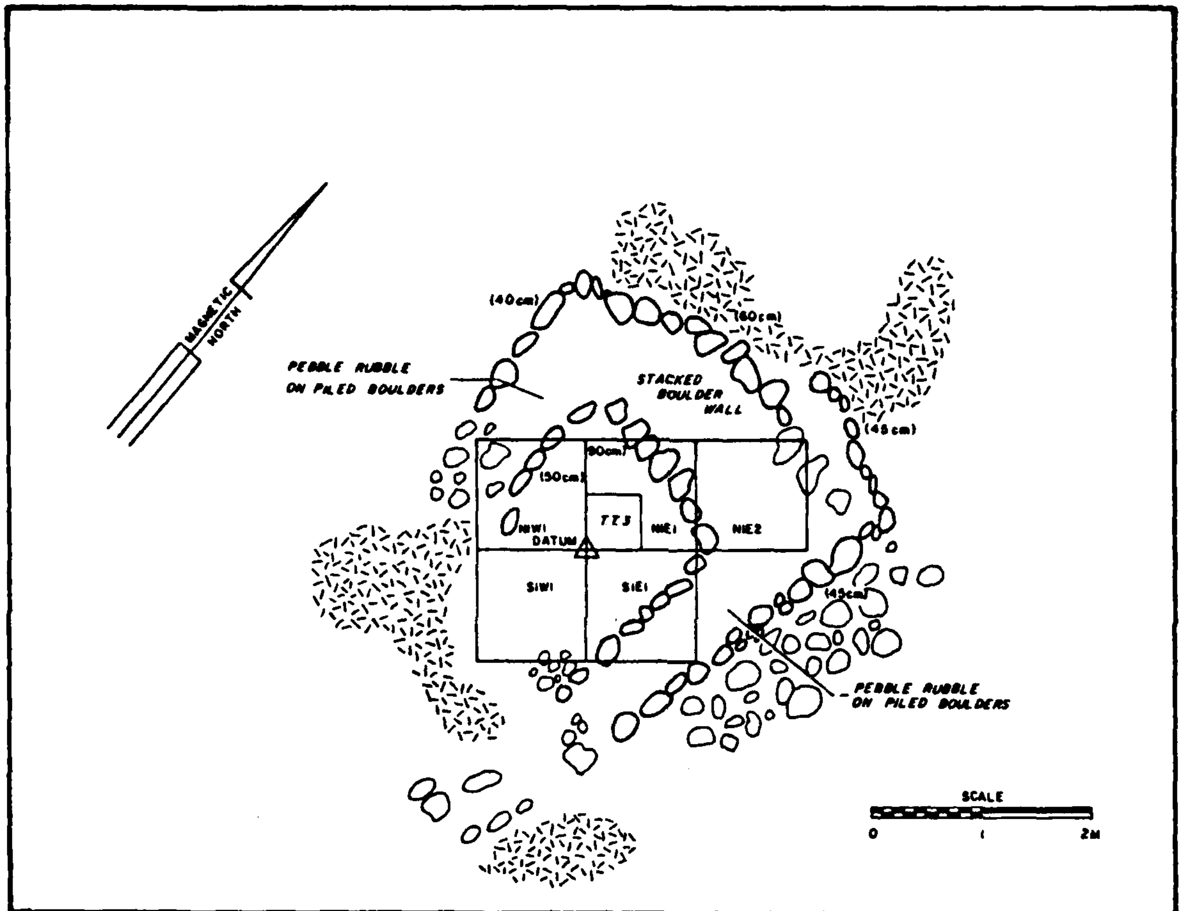


FIGURE 29 PLAN VIEW OF SITE 50-80-12-2732, SHOWING EXCAVATION GRID.

utilize raised and exposed bedrock surfaces for foundations. The east wall was underlain by sediments.

Five (5), one-meter square trenches excavated in the enclosure interior and beneath the north and east walls revealed three (3) stratigraphic layers.

UNIT I (10 YR 2/2) matrix of fine gravelly, cobbly silt loam, small boulders common; 0 and A1 horizon. High organic content. Thickness ranges from less than 3 centimeters to 10 centimeters, with a clear wavy boundary. Cultural midden is associated with this unit.

UNIT II A3 horizon. Matrix ranges from a fine gravelly, cobbly loam (10 YR 6/4) to a fine gravelly silt loam (10 YR 3/4) with cobbles common. This culturally sterile layer ranges from 10 centimeters to more than 20 centimeters in thickness.

UNIT III Reef limestone bedrock; C horizon. The surface is irregular and undulating.

Midden material is very sparse in Unit I and nonexistent in Unit II (Figure 30), however midden is densest in the trenches (N1W1 and N1E1) excavated in interior area of the site. The midden constituent of the site is comprised of sea urchin, *Nerita*, *Conus*, *Cypraea*, *Drupa*, *Terebra*, *Isognomon*, and charcoal bits. No artifacts are present in the excavated trenches.

A small (30-centimeter in diameter by 10-centimeter deep) deposit of very dark brown (10 YR 2/2) sediment is situated in the interior area of the structure in Stratum I where the sparse midden is densest. This dark colored deposit is probably the remains of a hearth.

Excavation of Site 2732 was discontinued because no artifacts were present and only very sparse quantities of midden were present. Archaeological data collected indicate that this site was occupied in

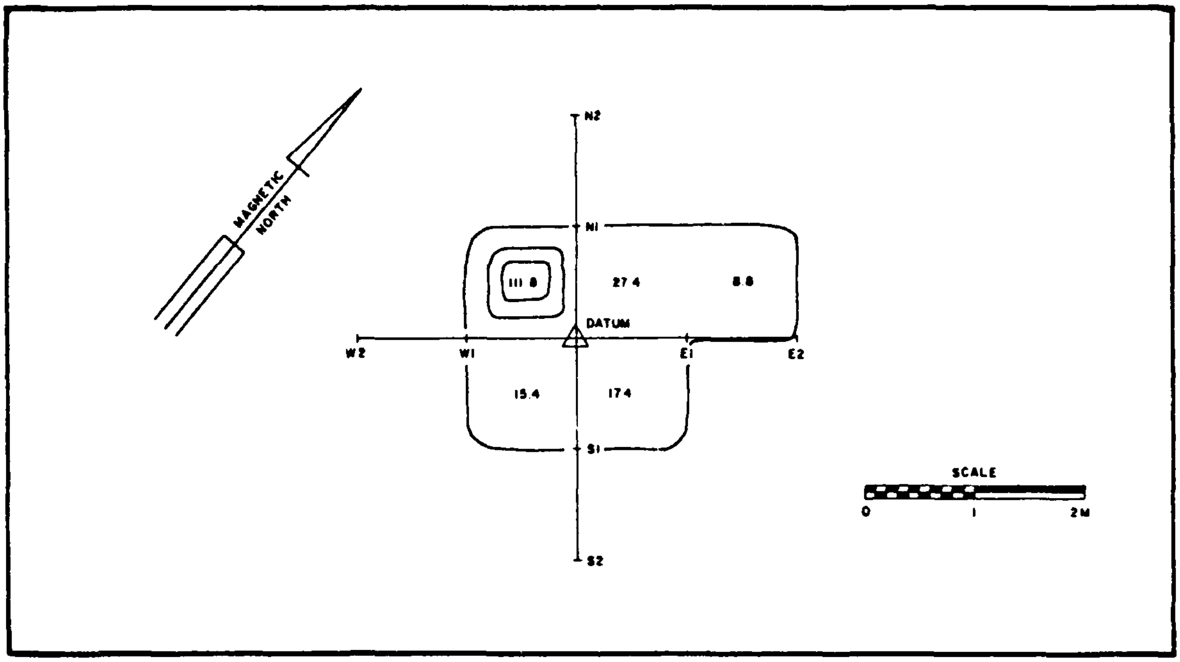


FIGURE 30 DENSITY CONTOURS (50 GRAM INTERVALS) OF MIDDEN WEIGHT STRATUM I, SITE 50-80-12-2732.

relatively recent times and that the intensity of human activity at the site was low.

Site 50-80-12-2745

Description

Site 2745 (Figure 31) is a very rough "L-shaped" rubble pile (wall remnants?) of limestone boulders up to one meter in size, lying on a fairly level exposed bedrock surface. The feature opens to the south and partially encloses a limited area of sediments to the south of the boulder rubble where a hearth is situated, sharply defined by a square border (80 by 80 centimeters) of partially buried upright slab shaped boulders. Exposed bedrock is present around the whole circumference of the site. A partially uprooted kiawe tree is located 2 meters south-east of the hearth. Southwest of this tree is a sink about 1.5 meters in diameter and 1.5 meters deep. This sink tapers down to a narrow bottom about 70 centimeters in diameter. The sink bottom contains gravity fill rubble and is deemed inferior for agricultural use because of the absence of soil. Other sinks located immediately to the south and north have similar characterisitics.

Excavation Results

The excavation of 2745 consisted of four (4), one-meter square trenches in the site interior around the hearth and a 50-centimeter square trench situated outside the north wall where sediments were present.

The stratigraphic units encountered are described here from top-most to lowest.

UNIT I — Recent 0 and A1 horizon, matrix of loose, fine, very gravelly silt loam (10 YR 2/2). Thickness ranges from 3 to 4 centimeters. Clear, wavy boundary. Very sparse shellfish remains present, probably derived from reworking of Unit II.

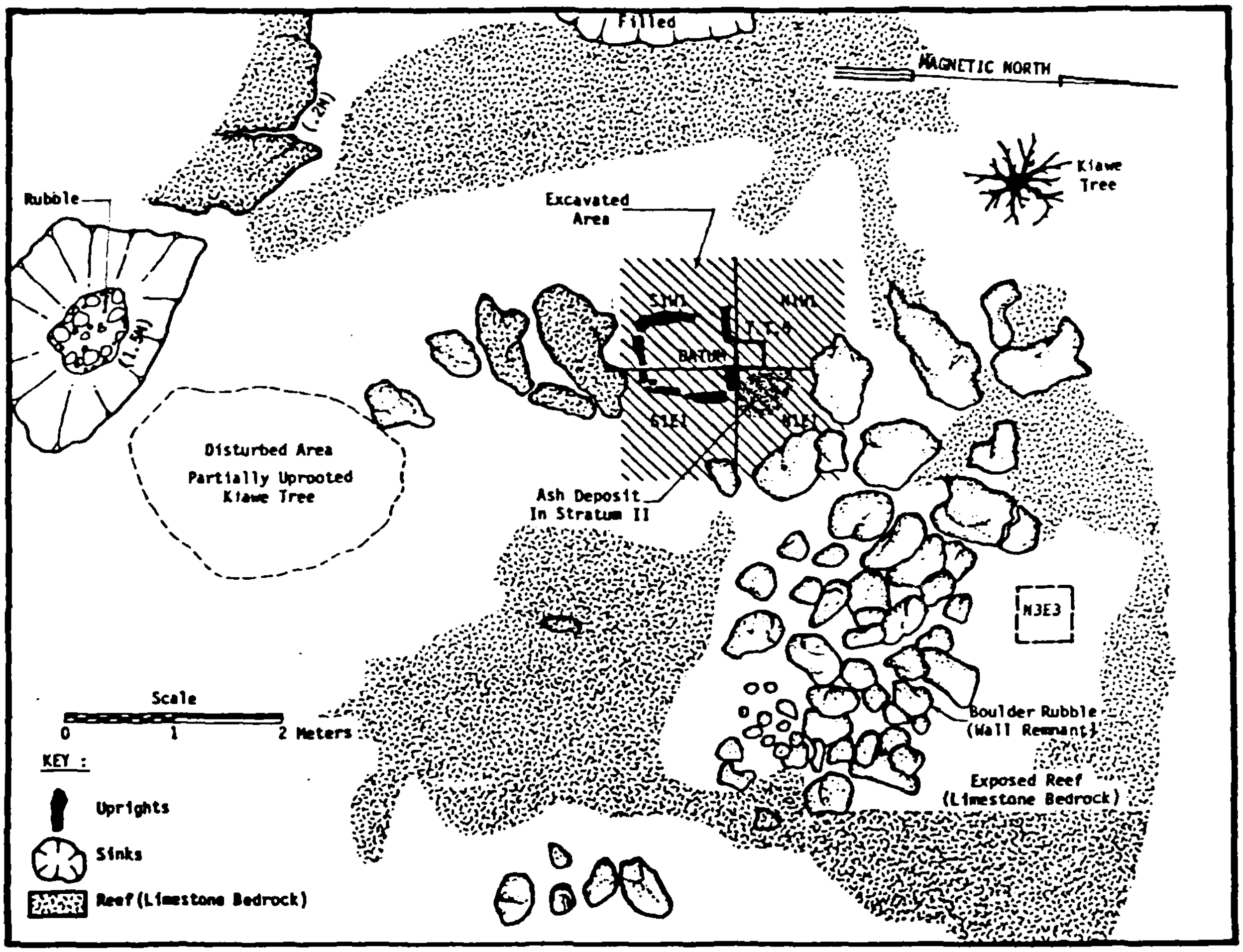


FIGURE 31
PLAN VIEW OF SITE 50-80-12- 2745.

UNIT II A3 (reworked C) horizon, matrix of very fine compact silt loam (10 YR 6/4, moist) with less than five percent fine to coarse gravel. Pebbles and roots common. Thickness ranges from 1 to 30 centimeters. The boundary is very abrupt and irregular. Cultural refuse is very sparse and an ashy deposit (reworked Unit IIA) is present at the surface of Unit II continuing to 12 centimeters below the surface. This unit continues to maximum depth of 23 centimeters but midden becomes even more sparse.

UNIT IIA This unit is present only within the hearth feature. Mottled (7.5 YR 7/2, 10 YR 5/1) matrix of very fine gravelly silt; This very compact, weakly cemented, unit (roots common) has a clear, wavy boundary. The concentration of midden is relatively dense.

UNIT III Reef limestone bedrock, with an irregular, undulating surface.

The cultural material derives from the uppermost 12 centimeters of Unit II (as mentioned before) and from the hearth layer (Unit IIA). Midden is sparse outside of the hearth, consisting of 55 percent pipipi (N. picea) and lesser amounts of Cypraea, Conus, Drupa, Brachidontes, Isognomon, Tellina, Crusteacea and bird and fish bone (Figures 32 and 33). No portable artifacts were present in the excavations. The only significant concentration of cultural material found outside the hearth was a thin, slightly sloping lens of mottled, whitish-grey to grey charcoal-flecked, ashy dirt in Stratum II, 2 to 9 centimeters thick and roughly 50 centimeters in diameter, situated a few centimeters northeast of the hearth feature.

The hearth is a nearly perfect 10-centimeter thick band that terminates abruptly against the upright perimeter stones delineating the hearth. The hearth perimeter stones are intrusive into Unit II exceeding or reaching the downward extent of the cultural refuse. The

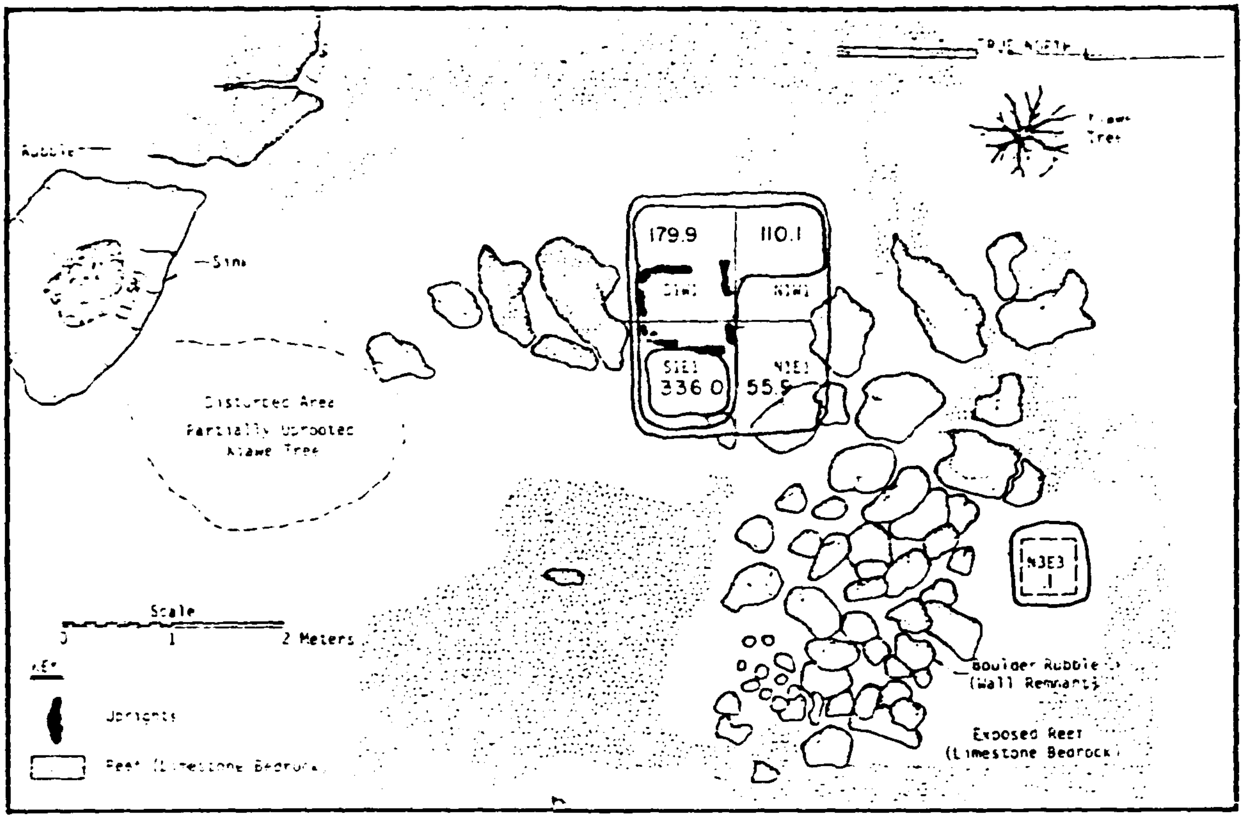


FIGURE 32 DENSITY CONTOURS (10 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM I SITE 50-80-12-2745.

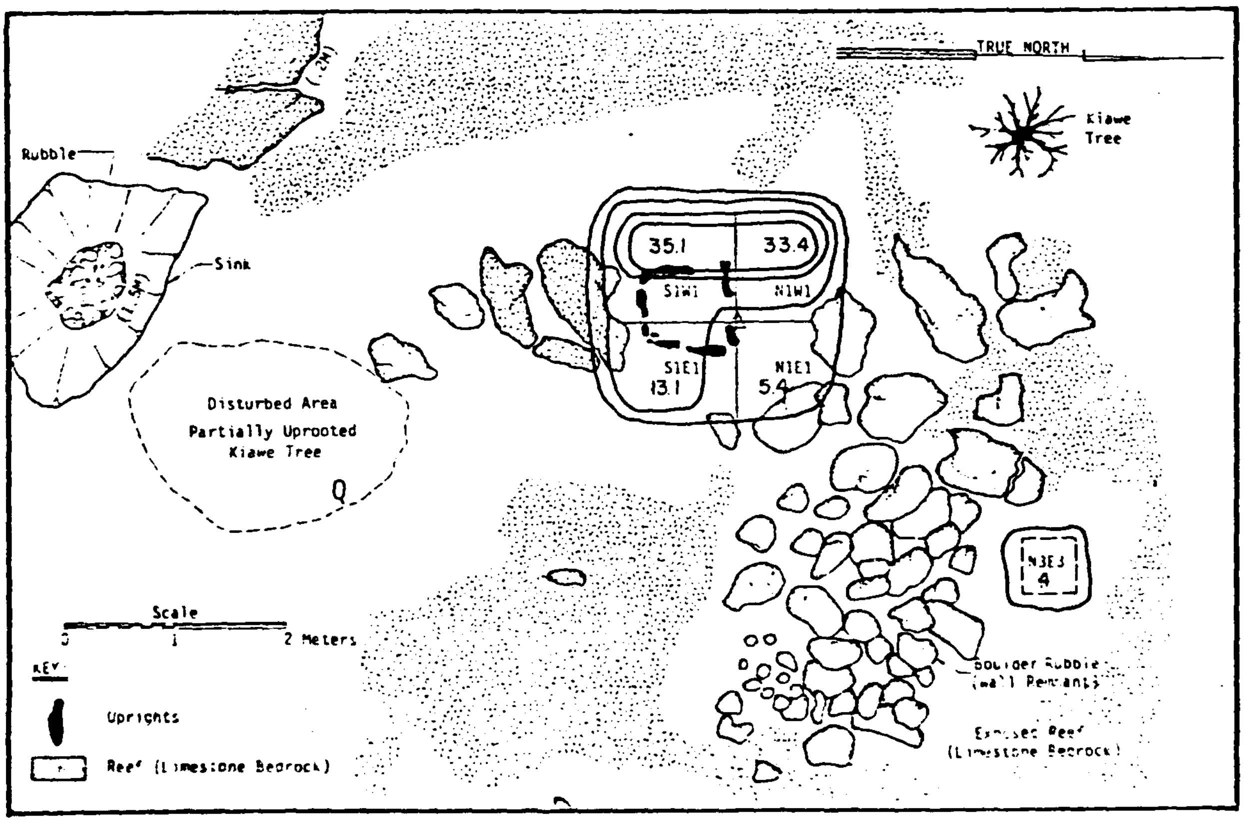


FIGURE 33 DENSITY CONTOURS (100 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM II

SITE 50-80-12-2745.

deposit in the hearth (Unit IIA) contained approximately 50 percent of the midden recovered during excavation.

The stratigraphic profile in the 50-centimeter square trench (N3E3, northeast quadrant), excavated outside of structure's north wall, correlated exactly with the profile within the structure. That is, a few fragments of sea urchin remains were collected from the uppermost 10 to 15 centimeters of the Stratum II deposit and there was no discernible division (of color, texture, etc.) in Stratum II besides the absence of midden below 15 centimeters.

The sequence of occupation of Site 2745, interpreted from the excavation data, is represented by a single stratigraphic unit focused upon a centrally located hearth. The contemporaneity of the rubble forming the "L-shaped" structure to the cultural deposit is uncertain because it is poorly preserved and because it is positioned on bedrock. Based on quantity of midden alone, this site probably represents a short-term activity.

Site 50-80-12-2763

Description

Site 2763 (Figures 34 and 35) is a roughly circular 2 to 2.5-meters diameter, bell-shaped solution sink, with a small oval-shaped opening approximately 1 by 1/2 meters. Access to the sink is facilitated by a low ahu of stacked limestone boulders in the sink built upon the cultural floor under the opening. This ahu appears to be a recent feature since it is placed on the surface of the sediments within the sink and was not noted during the surface survey (Davis 1978).

The interior walls of the sink are interrupted by abundant ledge-like horizontal protrusions extending from less than 1 centimeter to 15 or 20 centimeters out from the wall. Upon these ledges are floodlines of organic litter and dark reddish-brown silty clay loam, indicating a recent increase in silting from sugarcane-growing operations in the general area mauka and windward. These floodlines also indicate that Site 2763 partially fills with water during heavy rainfall, temporarily

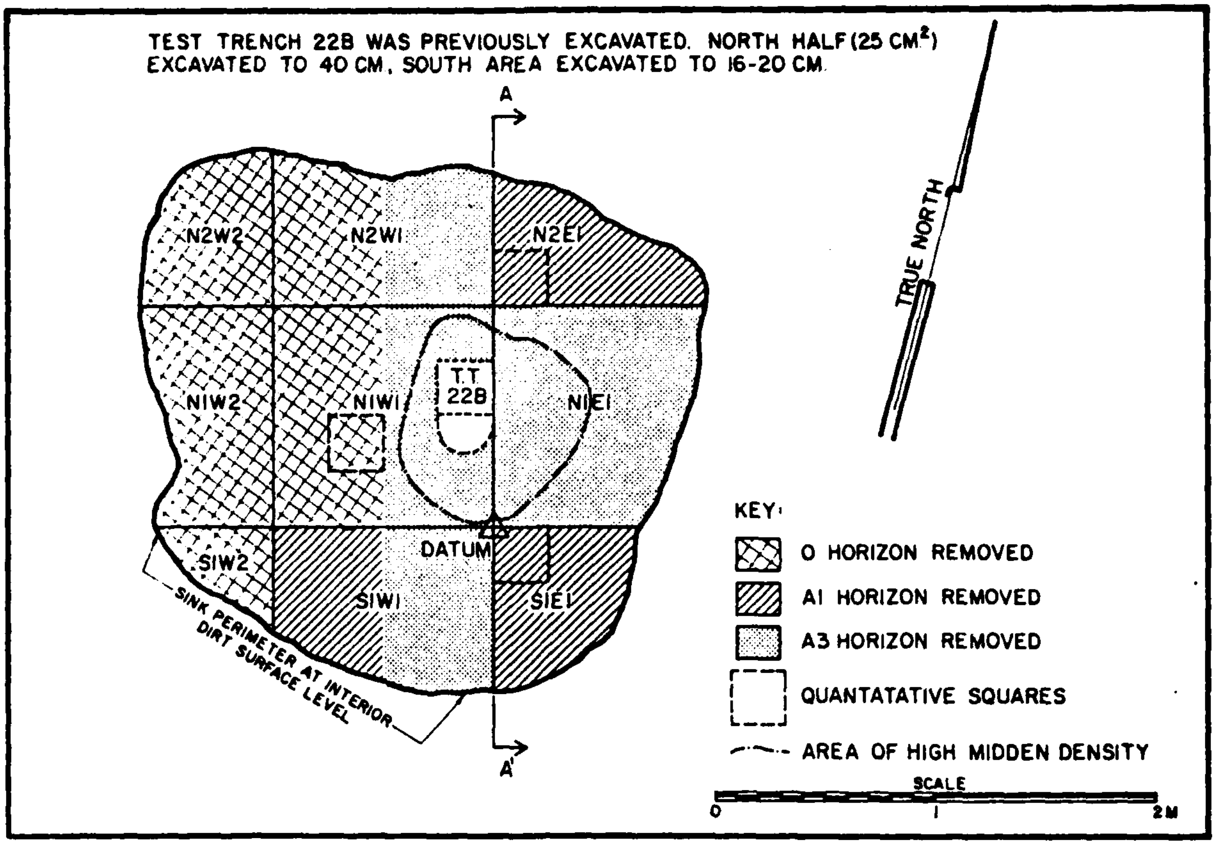


FIGURE 34 PLAN VIEW OF SITE 50-80-12-2763. SHOWING EXCAVATION GRID.

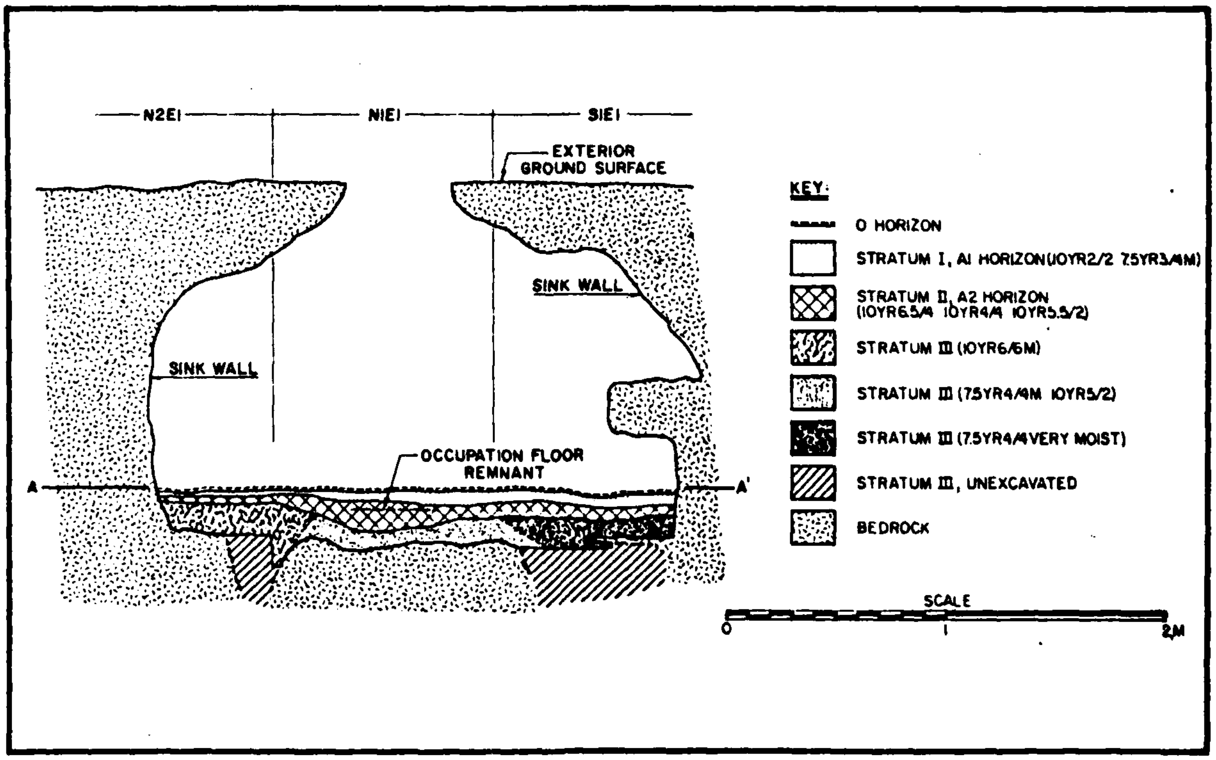


FIGURE 35 CROSS SECTION A-A' OF SITE 50-80-12-2763, SHOWING THE STRATIGRAPHIC LAYERS.

submerging the sediments. The lowest of these ledges (situated less than 10 centimeters above the surface of the sediments in the sink) have an occasional bird bone coated with silt. These bones were clearly transported by flood water.

Excavation Results

Excavations at Site 2763 consisted of first removing the A1 horizon delineated in the previous test trench (22B) across approximately 3 square meters in order to expose the surface of the A3 horizon (an occupation floor). A 50-centimeter wide trench was dug in the sink (from the northern to the southern extremes thus expanding the test trench) to determine the amount of strata variation evident from the discontinuous and wavy nature of the occupation floor. These strata are described below from the highest (0 and A1 horizons) to the lowest.

UNIT I — 0 and A1 horizons. Loose, well-sorted, dark (10 YR 2/2, moist; 7.5 YR 3/4, moist) organic silt. Cultural material and bird bones present in small quantities probably derived from mixing with Unit II. This unit is 4 to 11 centimeters thick, with an abrupt, smooth lower boundary. The unit contains a lens of carbonate powder adjacent to the sink walls.

UNIT II — A3 horizon. Loose fine gravelly silt loam, mottled (10 YR 3/4, moist; 10 YR 5.5/2, moist; 10 YR 6.5/4, moist). Cultural material present includes a discontinuous one to 2-centimeter thick, compact occupation floor remnant, with heavy concentrations of dark rumped petrel (Pterodroma phaeopygia) bones, as well as shellfish remains, fish bone and coral and limestone artifacts. The lower boundary is abrupt and wavy.

UNIT III	This culturally sterile unit of compact, silt loam, merging to clay loam, contains few bird bones.
UNIT IV	Reef limestone bedrock. Only small areas were exposed by the excavations.

The midden derived from the cultural layer (Unit II) included a variety of marine shellfish (but predominantly *Nerita picea*), with bones of petrel (*Pterodroma phaeopygia*), wood ash, and charcoal. A dense concentration of this midden is present in the central sink area below the sink opening. This deposit is roughly 1 meter in diameter and extends to a depth of 23 centimeters below surface. Thus, in the lowest portion of Unit II, bird bones are directly associated with human activity. The area of dense midden does not extend to the walls of the sink but does extend beyond the area of greatest concentration shown on Figure 34, decreasing in quantity and depth outwards from the center of the area of greatest concentration.

A slab-shaped sandstone boulder utilized as a grinding stone was situated in the middle of the dense midden area of Stratum II at a depth of 9 centimeters below surface and extending to near the lower boundary of the unit. A coral saw fragment and a coral file fragment, also present in Stratum II were situated along the east side of the dense midden area.

Excavation of the sediments below the *ahu* (mentioned in the site description) showed that the *ahu* did not extend below the surface, although the sediments were gravelly and cobbly beneath it. Thus this is probably a recent feature.

Site 50-80-12-9669

Description

Site 9669 is an oval-shaped sink complex comprised of two (2) adjoining sinks, each approximately 2 meters in diameter (not illustrated). The roof of the eastern sink is still intact, thus forming a cave entered by the western sink where the roof has collapsed, leaving a circular opening. The cave area of this site is roughly 2 by 3 meters, with a maximum ceiling height of roughly one meter. It has a level gravelly, cobbly, dirt floor and some small boulder rubble in the passageway from the open (western) sink to the cave area (of the eastern sink).

The cave floor has a thin 0 horizon (less than 3 centimeters thick) consisting mostly of forest litter. The 0 horizon is considerably thicker near the entrance passageway, where forest litter has accumulated in the sloping bottom of the open sink.

The site is situated on a low, wide knoll, a natural feature of the emerged reef topography. The area surrounding the site is disturbed on the north by a recent industrial trash dump and on the south by Malakole Road. The boundaries of both disturbances are located only a few meters from Site 9669.

A sparse scatter of midden consisting of Nerita picea, sea urchin and bird bone was observed on the surface of the sediments in the "cave" area of the site and artifacts (a bone pick and four [4] sandstone flakes) were collected.

Excavation Results

Excavation of Site 9669 was initiated with a one-meter square trench in the central area of the cave. The excavation was reduced to a 1 meter by 1/2 meter (the southern half of the original trench) due to the extremely low density of cultural material present. Excavation of this trench was continued to a depth of 40 to 45 centimeters below surface to define the stratigraphic units present and to analyze their content. The units present in the excavation are described below from topmost to lowest.

UNIT I — A1 horizon (10 YR 2/2.5) fine, gravelly silt loam. The average thickness at rear of cave is 2 centimeters. Cultural material consisting of shellfish remains is scattered sparsely on the surface and in this A1 horizon. Four sandstone flake artifacts were present in the 0 to 5 centimeter level; some bird bones (petrel) were recovered.

UNIT II C horizon (10 YR 6/4). Matrix of fine, very gravelly silt loam. Depth below the surface ranges from 2 to 3 centimeters to more than 45 centimeters. The deeper portion of this unit within the limits of the excavation becomes more cobbly and less gravelly and changes color gradually to (10 YR 4/4, moist). The culturally sterile unit contains some bird bones, fossilized shell fragments, and some crab pincer parts (possibly deposited by birds or other animals).

Because of the low density of midden, its restriction to Unit I, the absence of evidence for manufacturing activities, and the absence of a stratified, culture-bearing A3 horizon, excavations at this site were terminated. This site probably functioned as a temporary shelter cave and may have been occupied only once for a brief period. The association of the midden and petrel bone components in Unit I provides a tentative relative date for the occupation of this site.

Site 50-80-12-9682

Description

Site 9682 is a roughly circular enclosure constructed of limestone and sandstone boulders (Figure 36). Although this site is very poorly preserved, numerous uprights and inclined slabs (fallen uprights) indicate a core-filled construction style of boulder and cobble fill. A subfeature of the site consists of a small, leveled area of boulders incorporated into the east section of the enclosure wall. This lanai-like feature is formed by a foundation of boulders up to one meter in size upon which smaller slab-shaped boulders are placed flat as a rough pavement. The broad area around Site 9682 has been disturbed

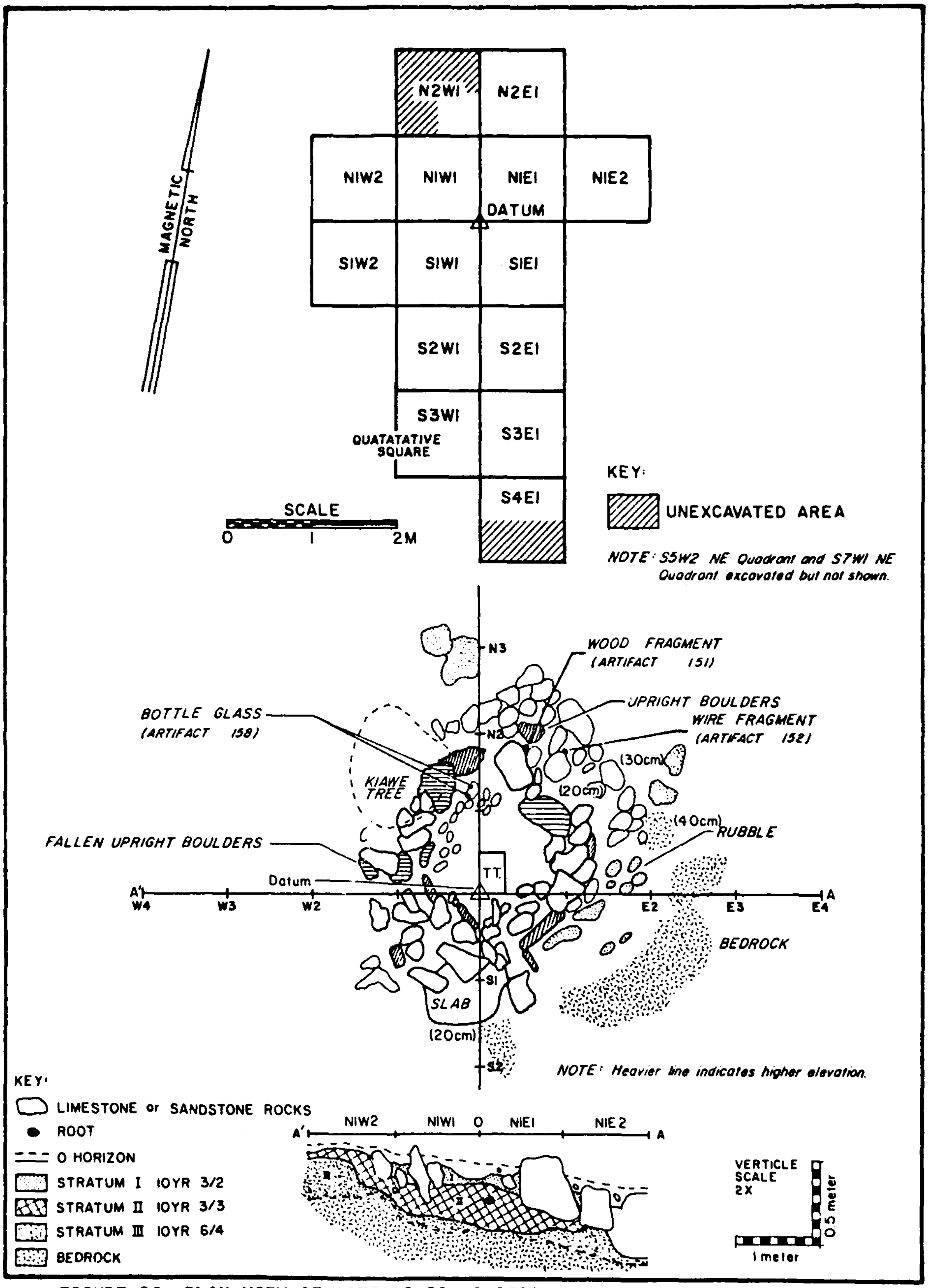


FIGURE 36 PLAN VIEW OF SITE 50-80-12-9682, SHOWING EXCAVATION GRID.

evidenced by the koa haole stands, abundant cut and burned kiawe stumps, and large uprooted kiawe trees.

This site is situated some 50 feet west of the large pond at the southeast corner of Study Area 1b and the area has an abundance of sandstone deposits evidenced by the high proportion (approximately 50 percent) of sandstone to limestone boulders used in the site structure.

Excavation Results

Four (4) strata are present in the excavations. These are, from topmost to lowest:

UNIT I — 0 and A1 horizons. Matrix of fine, gravelly silt loam (10 YR 3/2). Thickness ranges from 2 to 10 centimeters. This unit contains few historic and prehistoric (?) artifacts, some shellfish remains and cow bones; it has a clear, wavy lower boundary.

UNIT II — A3 horizon. Matrix of fine, very gravelly silt loam (10 YR 3/3). The average thickness of this unit is 15 to 20 centimeters. The boundary is clear and wavy. The unit contains concentrated cultural inclusions, consisting of shellfish remains, fishbone, mammal bone, charcoal, and prehistoric (?) artifacts of bone, shell, coral, and basaltic glass.

UNIT III — C horizon. Fine, gravelly silt loam; 2 centimeters or more thick, this unit fills interstices of cracks in bedrock. It is culturally sterile.

UNIT IV — Reef limestone or sandstone bedrock.

During the clearing of the structural component and surrounding rubble of Site 9682, historic bottle glass fragments and a piece of straight fence wire were found in the site's interior and between the

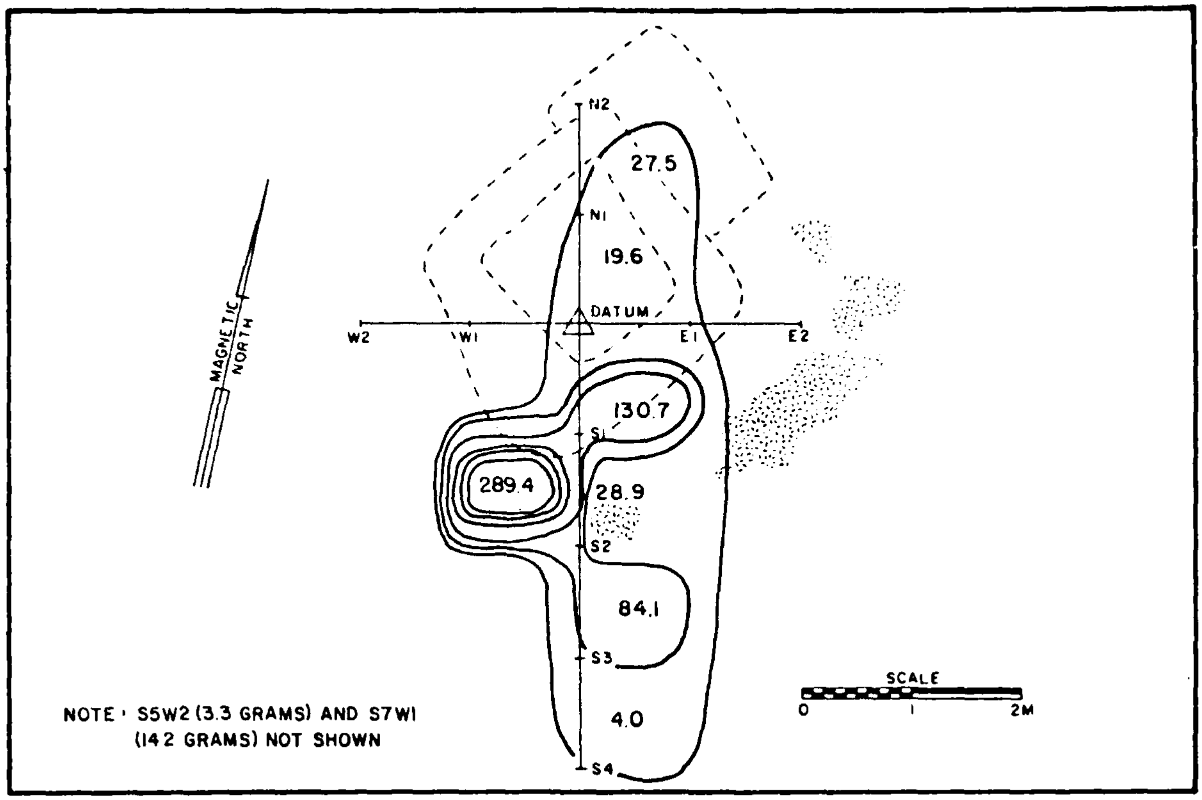


FIGURE 37 DENSITY CONTOURS (50 GRAM INTERVALS) OF MIDDEN WEIGHT. STRATUM I.
SITE 50-80-12-9682.

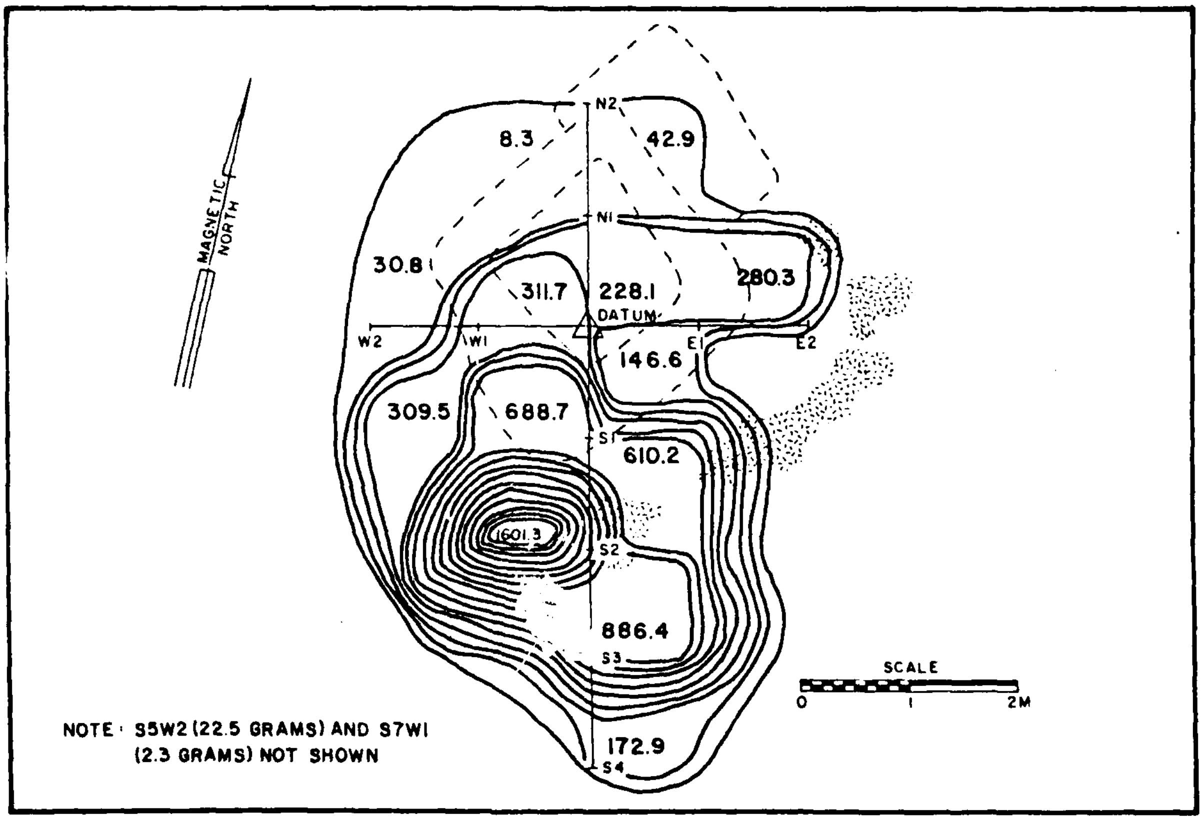


FIGURE 38 DENSITY CONTOURS (100 GRAM INTERVALS) OF MIDDEN WEIGHT. STRATUM II.
SITE 50-80-12-9682.

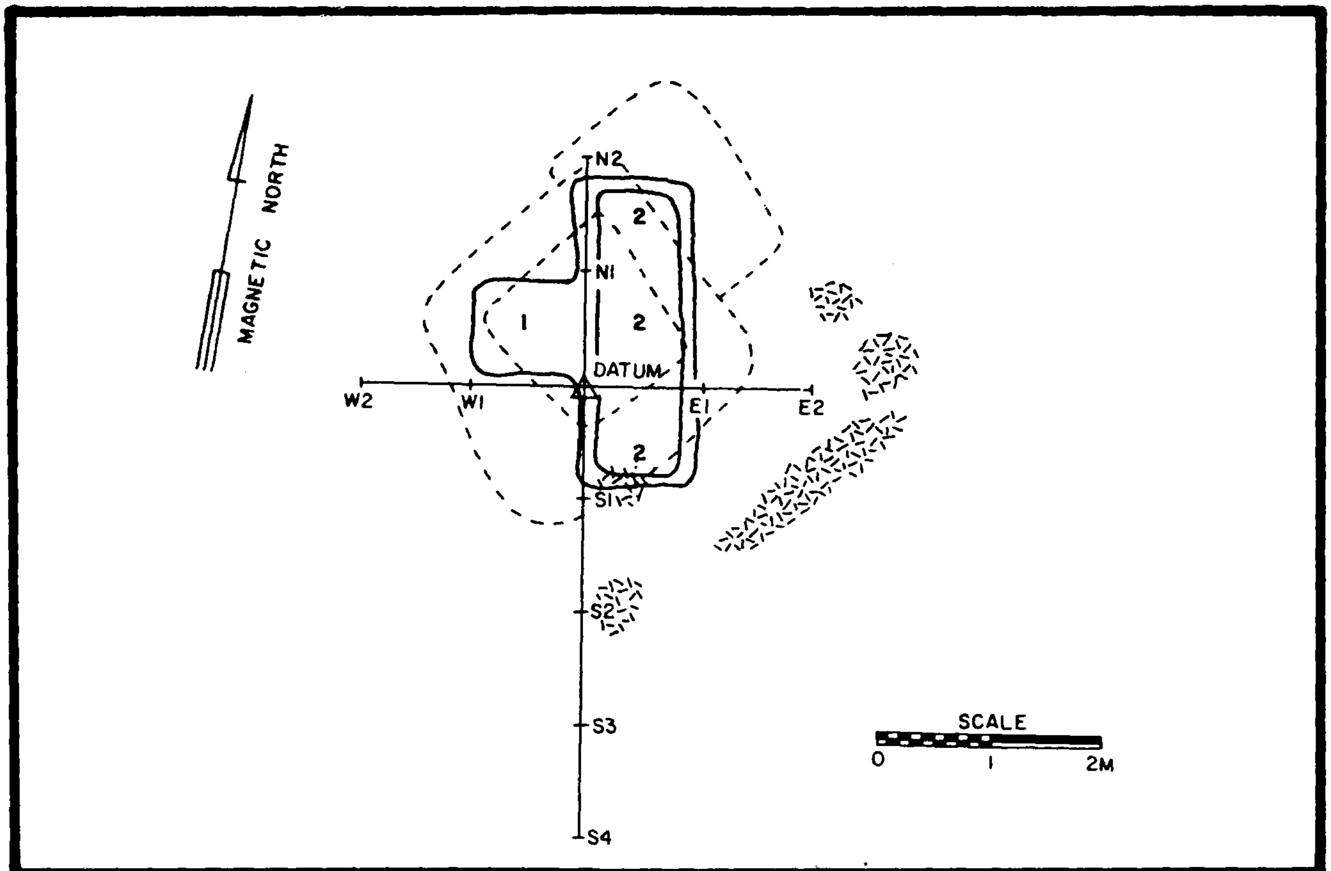


FIGURE 39 DENSITY CONTOURS (INTERVAL-1) OF ARTIFACTS BY FREQUENCY, STRATUM I
SITE 50-80-12-9682.

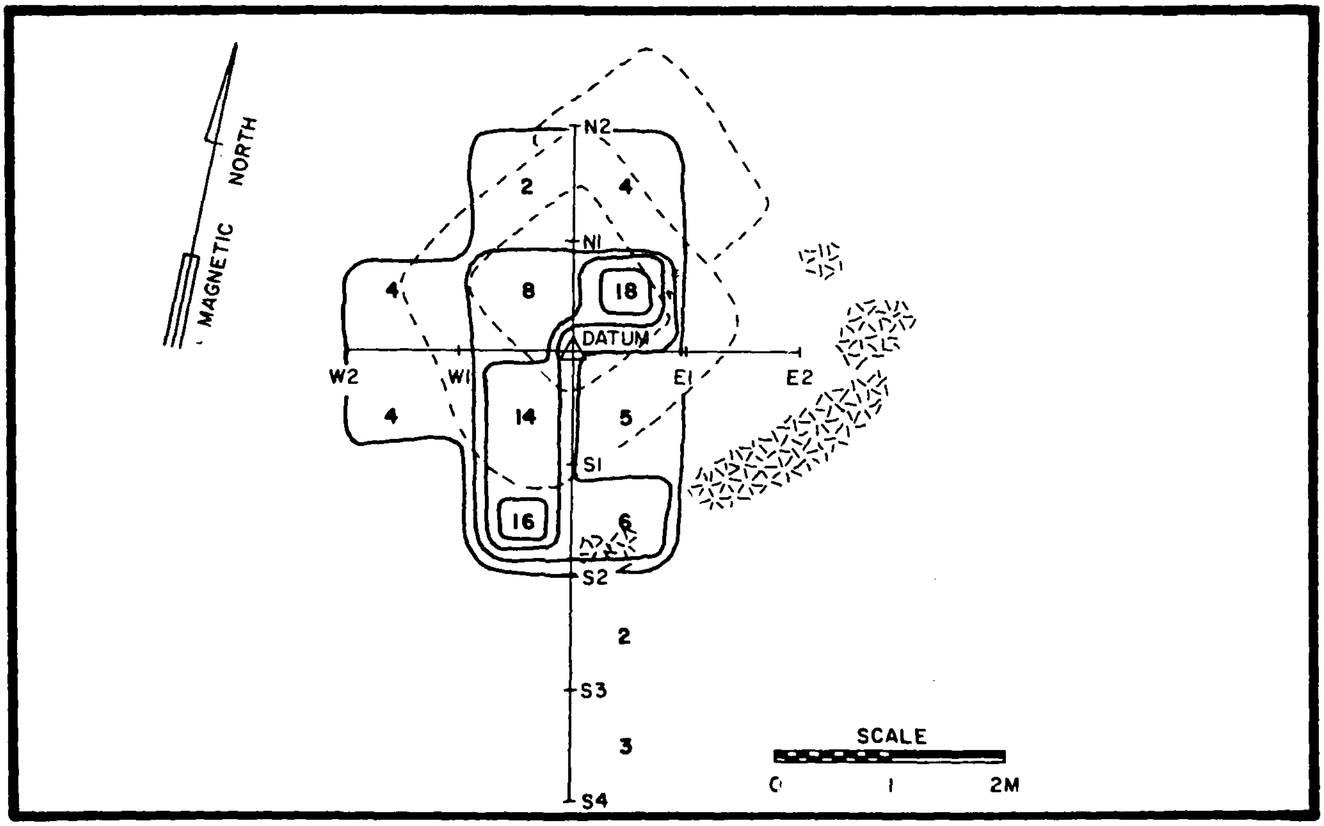


FIGURE 40 DENSITY CONTOURS (INTERVAL-5) OF ARTIFACTS BY FREQUENCY, STRATUM II
SITE 50-80-12-9682.

boulders of the lanai area, respectively. Excavation of the interior area of the enclosure revealed an absence of nonportable artifacts associated with Unit I (see Figures 37 through 40).

Unit II contains large quantities of shellfish remains, including 74 percent (by weight) Nerita picea, the remainder being comprised of predominantly Conus, Cypraea, Drupa, Turbo, Tellina, Brachidontes, Isognomon, sea urchin, Crusteacea, and bird and fish bone. A single fragment, tentatively identified as Charonia tritonis, and a pig tusk fragment are also present. This cultural material is concentrated in the upper 5 to 15 centimeters of Unit II.

The extension of the excavation trenches toward the west and north revealed that the horizontal limit of Unit II does not continue in this direction beyond the structural walls. An extension of Trench N1 toward the east showed a considerable decrease in the midden component of the unit in this direction. Excavations extended to the south of the structure revealed increased quantities of midden outside the structure for a distance of about 4 meters. The density of midden then decreases abruptly. An ash lens was encountered in S7W1 about 6 meters south of the enclosure structure. It is 3 centimeters thick and 20 centimeters wide in the profile of the trench.

The artifactual material deriving from the excavation of Unit II consists of coral cutting and abrading tools, fishhooks, cut bone fragments, shell beads, and basaltic glass.

The sequence of events occurring at the site can be summarized as follows:

1. Initial occupation; and construction of a surface structure upon Unit III surface.

2. Continued permanent or temporary use of the site and consequent formation of Unit II and deposition of large amounts of midden. Disposal patterns of artifacts and midden correspond exactly peaking in Trench S2W1 outside of the site adjacent to a slab boulder set horizontally upon the foundation stones of the wall.

3. Abandonment of the site.

4. Recent activities of cattle ranching and kiawe logging occurring with possible reconstruction of the earlier feature for infrequent temporary period(s) of use.

Site 50-80-12-2768

Description

Site 2768 is a large, rectangular enclosure remnant measuring 7 meters north to south by 5.5 meters east to west (Figure 41). The structural walls are built with reef limestone boulders, utilizing a stacked boulder-faced, core-filled style. A clearly defined entranceway truncates the south wall, and the north wall is reduced to a nondescript rubble pile with none of its foundation stones discernible. A previous B.P. Bishop Museum test trench (Sinoto 1976:35, Site B6-71) is centrally located within the enclosure. Exposed bedrock, visible at various points in the enclosure interior, becomes more extensive to the north. A kiawe tree is growing in the north end of the structure's west wall.

The structure is situated just mauka of an extensively bulldozed area containing remnants of modern (presumably military) structures and other features. The closest sinks are concentrated to the west and southwest of Site 2768, but only one contained cultural modifications or material in the form of recent historic material. The vegetation in the immediate area shows evidence of previous kiawe tree-cutting as well as the bulldozing activities already noted.

Excavation Results

Excavation trenches in Site 2768 are concentrated at the south end of the enclosure interior near the entranceway (N1E1, N2E1, and N2E2). Trench N2E3 truncates the east wall, providing a cross section

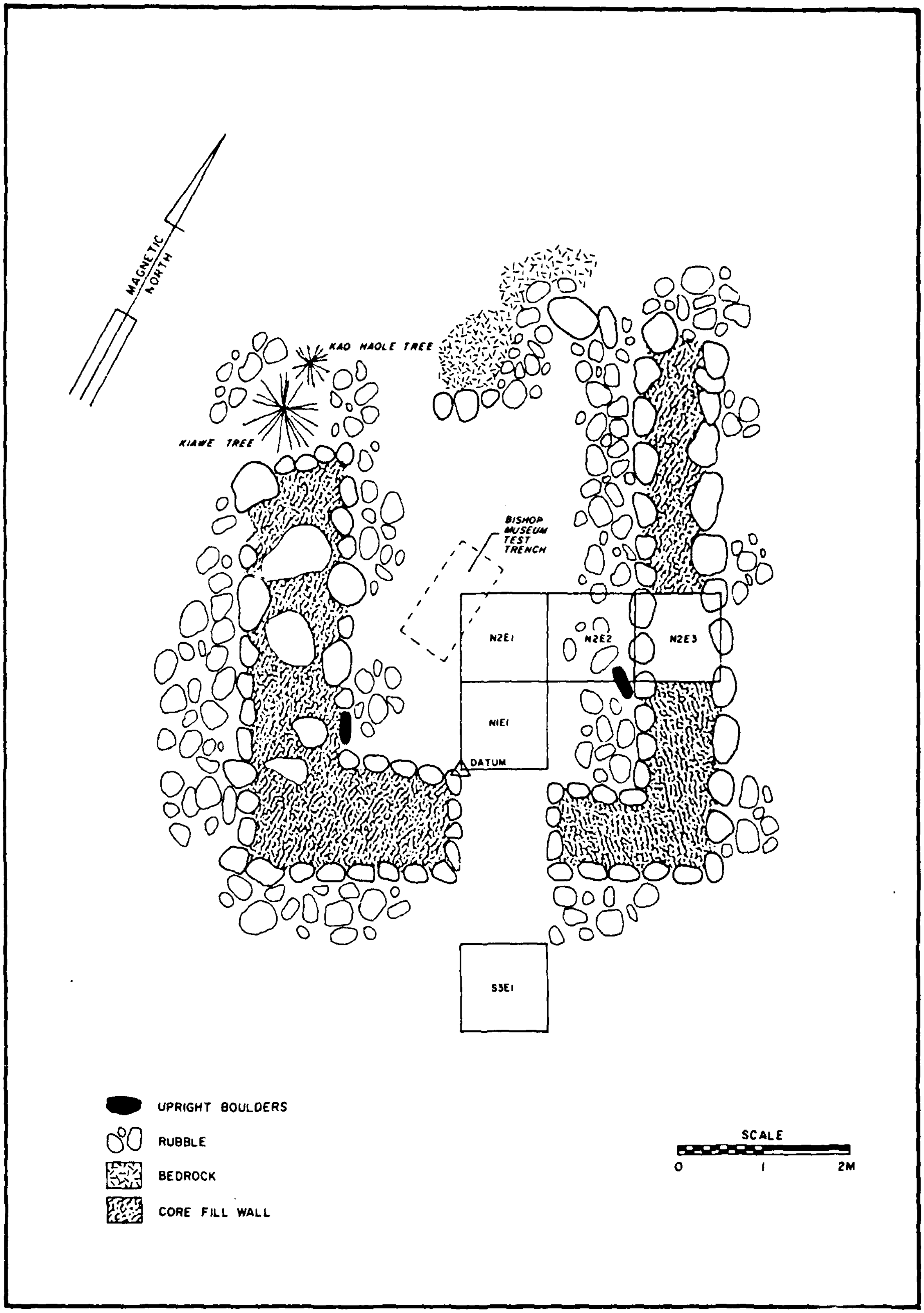


FIGURE 41 PLAN VIEW OF SITE 50-80-12-2768.
SHOWING EXCAVATION GRID.

which shows the contemporaneity of the wall foundation stones and Stratum II, a cultural layer. Trench S3E1 is located 70 centimeters outside of the entranceway.

Four (4) distinct stratigraphic units were defined.

UNIT I	Recent O and A1 horizon with a matrix of loose, very gravelly and cobbly silt loam (10YR 2.5/1.5); Thickness ranges from 3 to 8 centimeters. Roots are common. An abrupt wavy boundary changes to a discontinuous, irregular boundary beneath structural walls. Some shell fragments and charcoal bits possibly derived from mixing with a lower stratigraphic unit were found.
UNIT II	Prehistoric (?) A3 horizon (10YR 3/3) with a matrix of fine cobbly silt loam, lightly compacted and weakly cemented. Thickness averages from less than one to 4 centimeters and extends to a maximum depth of 20 centimeters below surface in the interstices of faulted bedrock slabs. This cultural layer contained very sparse midden and no artifacts.
UNIT III	Fine gravelly silt matrix (10YR 6/4); C horizon. It has an abrupt, irregular, discontinuous boundary. No cultural material was found.
Unit IV	Reef limestone bedrock.

Subsurface features were absent in the excavation trenches except the numerous cobbles in Unit II which probably served to level the bedrock substratum. These cobbles were not arranged in any specific pattern other than being concentrated in cracks and depressions of the bedrock.

No artifacts were present in the excavations and midden is very sparse (Figures 42 and 43). The midden component of Stratum I

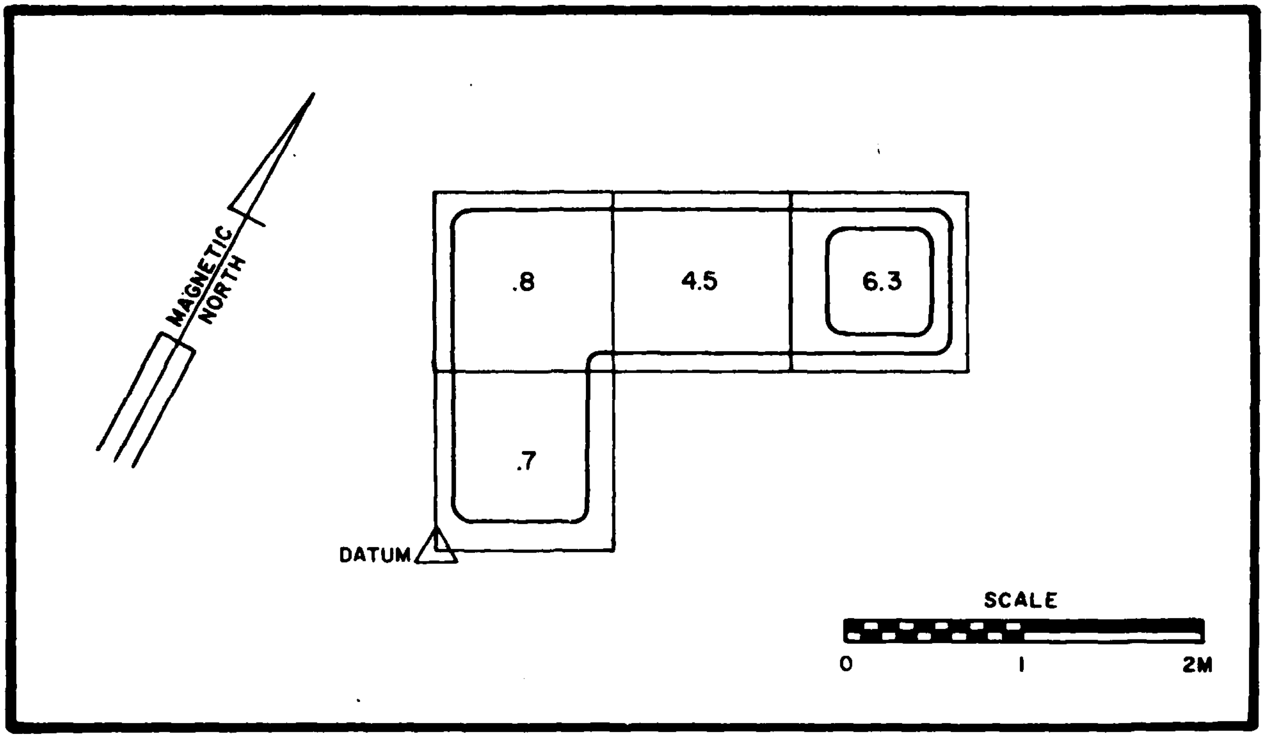


FIGURE 42 DENSITY CONTOURS (5 GRAM INTERVAL) OF MIDDEN WEIGHT, STRATUM I, SITE 50-80-12-2768,

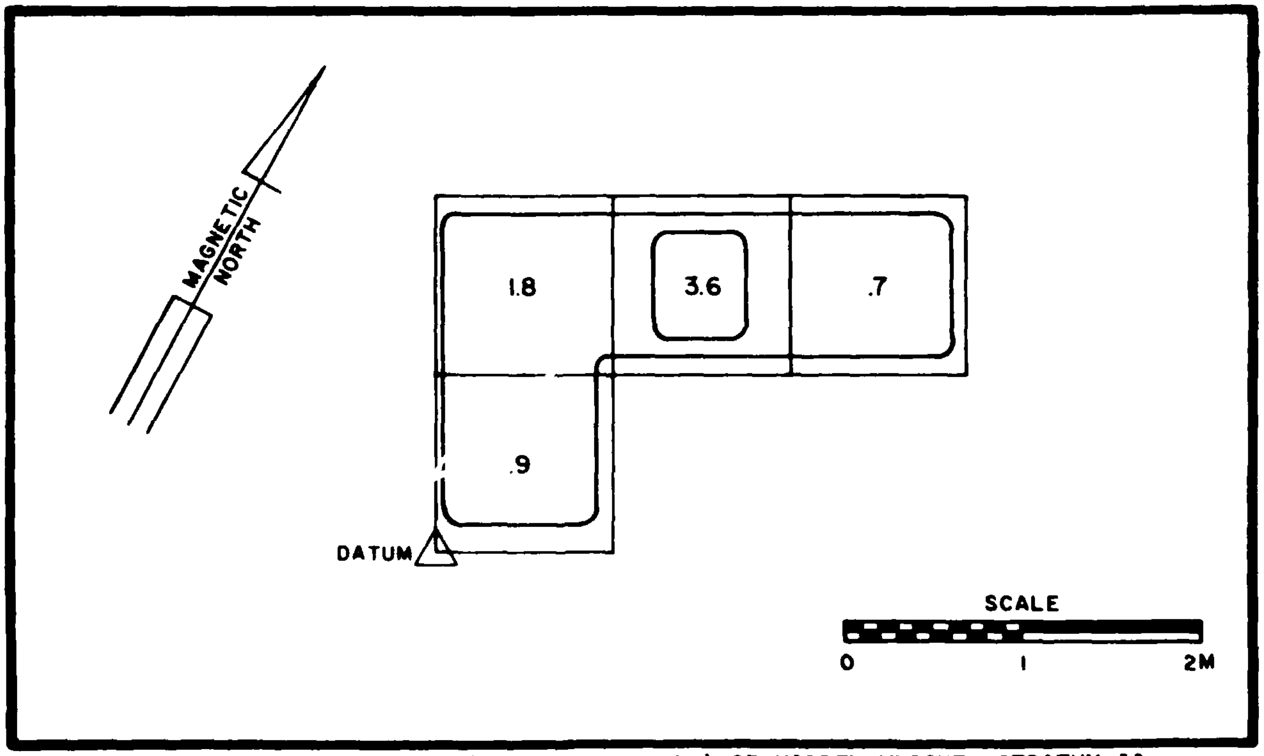


FIGURE 43 DENSITY CONTOURS (3 GRAM INTERVAL) OF MIDDEN WEIGHT, STRATUM II, SITE 50-80-12- 2768.

consists of shellfish remains (sea urchin and Tellina) and charcoal bits from Trenches N1E1, N2E1, and N2E3. The charcoal bits are probably modern deriving from charred, chain-sawn kiawe stumps present nearby. The sea urchin and clam shell fragments were probably from Stratum II. Clam (Tellina) is a common fossil in the local limestone bedrock.

The midden component of Stratum II, also sparse, consists of sea urchin, clam, and charcoal bits found in the trenches excavated in the enclosure interior. Trench S3E1 situated outside the structure entrance, contains no midden at all.

The proximity of Site 2768 to a recent military structure remains and associated disturbed areas suggests a modern origin, except no historic artifacts were found at the site. In addition the construction design, kind of midden material, and especially the presence (although discontinuous) of a premodern A horizon strongly suggest that the structure was built, used, and abandoned before modern military use of the area. Absence of portable and nonportable artifacts, unusually low midden density, and relatively large size of the structure suggest that Site 2768 might have been a hale moe or for some other specialized function and that other associated structures have been obliterated since the time of abandonment.

Site 50-80-12-2777

Description

Site 2777, a square structure enclosing a 4-square meter area, is formed by four (4) walls constructed of reef limestone rocks (Figure 44). The walls of the enclosure have a core-filled type of construction incorporating upright slab-shaped and stacked polygonal-shaped boulders to form the interior and exterior wall faces. The core filling consists of boulders, cobbles, and pebbles. These walls average one meter wide and are presently 30 to 40 centimeters high. Large amounts of rubble give the walls a mounded appearance and indicate that they

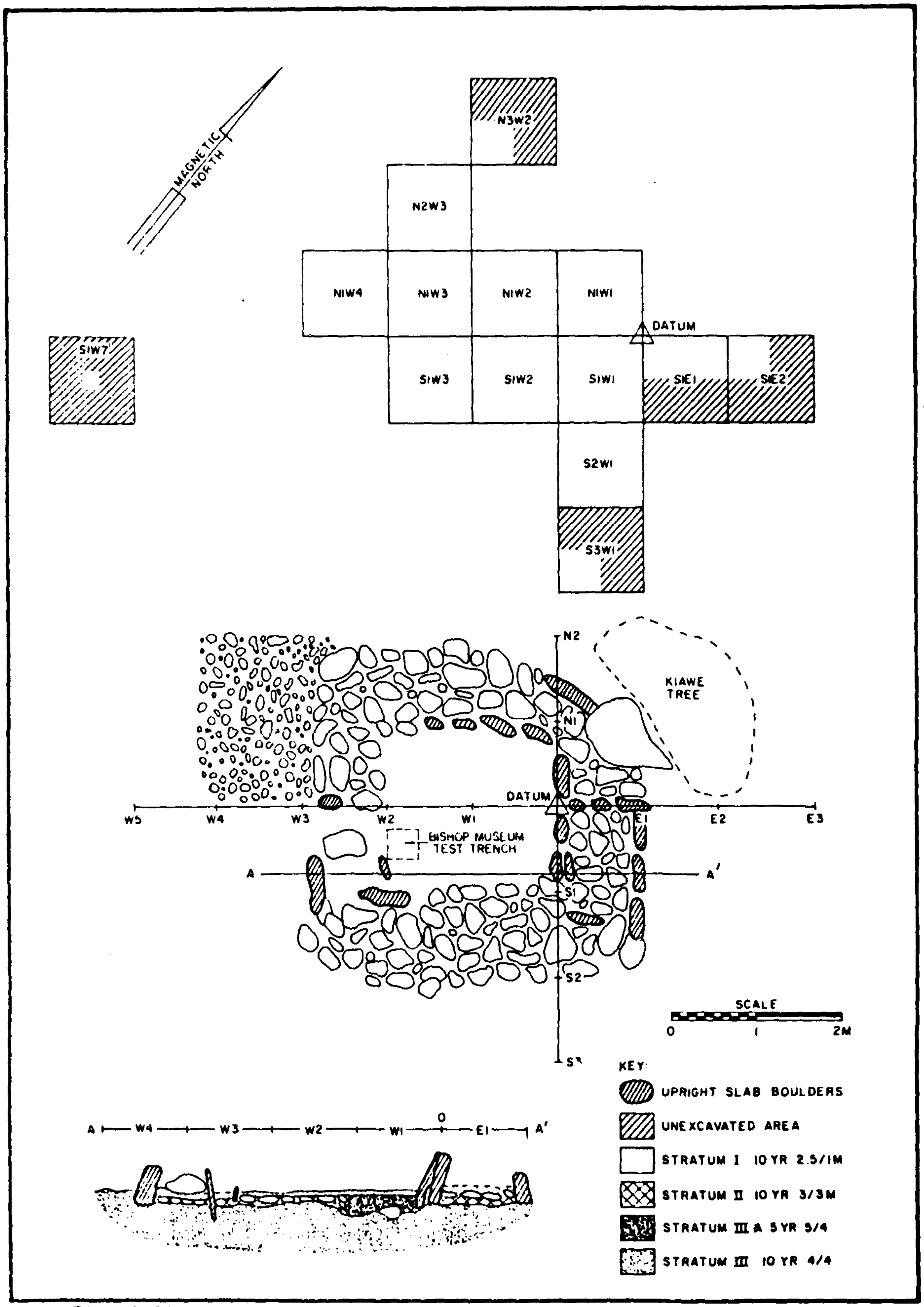


FIGURE 44 PLAN VIEW OF SITE 50-80-12-2777, SHOWING EXCAVATION GRID AND CROSS SECTION.

were higher at one time. An entranceway truncates the (relative) west wall and is defined by an upright slab-shaped boulder on each side of the passage way. No interior or exterior subfeatures were observed before excavation except a large slab boulder exposed above the ground surface in the northeast corner of the enclosure interior. A small cobble-sized vesicular basalt fragment was found atop the rubble of the north wall (located on Figure 44).

The immediate area surrounding Site 2777 is disturbed by uprooted and logged kiawe trees, exposed bedrock, and a few solution sinks. Other sinks, if present, are obscured from view beneath sediments. A wet sink (Site 50-80-12-2785) is situated approximately 100 feet to the south-southeast of Site 2777 and probably served as a source of drinking and bathing water for the inhabitants. Site 50-80-12-2784 is also located nearby.

Excavation Results

Dismantling the walls of the surface component of Site 2777 confirmed the presence of in situ foundation alignments of partially buried uprights and stacked boulders. A possible collapsed cupboard is present in the east wall, at the southeast corner of the structure. It is roughly rectangular and is delineated on the west and east by the interior and exterior faces (respectively) of the east wall; on the south by a single upright buried beneath the core-filled center of the east wall; and on the north by a line of three uprights oriented perpendicular (east to west) to the long axis of the east wall and buried beneath the core fill. The cupboard floor is formed by a pavement of small slab-shaped boulders set horizontally at ground level forming a level surface. This floor pavement is similar to the pavement found in the site interior (discussed below).

Excavation trenches in the interior of the structure established the presence of four stratigraphic units described here from uppermost to lowest. (Refer to Figure 44).

UNIT I Very dark grey to black (10YR 2.5/1, moist) matrix of fine loose, gravelly, silt loam; high organic content with many rootlets; recent O and A1 horizon. Thickness ranges from 2 to 7 centimeters with discontinuous, weak orientation and a clear, wavy boundary. Sparse cultural material is probably reworked.

UNT II Dark brown (10YR 3/3, moist) matrix of lightly compacted to very compacted, fine, gravelly and cobbly silt loam with many rootlets. Thickness ranges from 5 to 22 centimeters; weakly cemented. This unit contains cultural midden and portable and nonportable artifacts. The boundary is abrupt and wavy.

UNIT III Light yellowish brown (10YR 4/4, moist) matrix of compact, weakly cemented, fine, gravelly and cobbly silt to silt loam. Thickness ranges from less than 1 centimeter to more than 10 centimeters. Cultural material is found only in the uppermost 2 to 3 centimeters. The boundary is abrupt and irregular.

UNIT IV Reef limestone bedrock with fault cracks and solution pits. This unit has a smooth surface.

A very dark grey charcoal-stained and flecked hearth layer is present within Stratum II in the southeast corner of the enclosure interior (in Trench S1W1). This hearth layer is bounded on the east by the interior face of the structural walls and on the south and west by a rough semicircular limestone cobble border. It extends from the surface of Stratum II to 15 centimeters below the present ground surface and is a very dark grey (10YR 3/1, moist) to greyish brown (10YR 5/2, moist) fine, gravelly silt loam, fairly compact with ash and charcoal flecks. There is a single, small, fire darkened, reef limestone cobble in the matrix. The lens ranges from 13 to 15 centimeters thick in the center of the hearth, thinning toward the bowl-shaped edges and has a clear, wavy, boundary. Beneath the hearth layer is a reddish brown (5YR 5/4) lens of fire-altered Stratum III, 2 to 6 centimeters thick.

A slab boulder pavement extends from the hearth in the southeast corner of the interior to the entranceway in the west wall and continues into the entranceway itself. The boulders of this pavement are situated within Unit II. Some boulders contact the Stratum III surface and their interstices are filled with Stratum II sediments.

Five separate trenches were excavated in sections of the wall foundations. Trench S2W1 in the south wall revealed a stacked boulder interior and exterior foundation buried in Stratum II. The lowest stones were set upon Stratum III with a boulder fill between the two alignments. In the wall faces above this stacked boulder foundation are some upright slabs. Trenches S1E1 (northern half) and S1E2 (northwest quadrant) excavated through the east wall (that is, the north end of the collapsed cupboard) revealed that the upright slab wall foundations and the uprights forming the north border of the cupboard are set upon the sterile Stratum III surface and that the pavement of the cupboard floor is situated within Stratum II. Three (3), 1 meter excavations in the west wall showed the construction of the entranceway. It is suggested that this wall is contemporaneous with the rest of the structure and the stratigraphic cultural unit (II). However a circular-shaped layer of very compact ash in N1W3 (35-centimeter diameter and 2 to 3 centimeters thick) situated directly on the bedrock substratum (Unit IV) beneath the lowest stones of the west wall's foundation conclusively show that this hearth feature predates the west wall. Nevertheless, it is contained in the lowest level of Unit II and probably resulted from initial occupation during the construction of the site.

A third hearth feature immediately outside the entranceway is also associated with the culture-bearing Unit II. This feature is roughly circular with a diameter of 42 centimeters. It is intrusive into Stratum III, is a shallow bowl shape in cross-section, and contains six fire-altered limestone cobbles grouped together in the bottom center of the feature. No midden, artifacts, nor charcoal was present.

Three additional 50-centimeter square excavations (N3W2, S1E2, and S3W1) and one 20-centimeter square trench (S1W7) were placed outside the structure to ascertain the lateral extent of the culture-bearing Stratum II. The areas north and west of the structure apparently functioned as integral parts of the site as a whole since Stratum II was discernible and contained small amounts of midden material. South of the structure, Stratum II was present as a thin layer but cultural midden was absent. East of the structure Stratum II pinches out immediately outside the wall.

Midden and artifact distribution is shown in Figures 45 through 47. A total of eight (8) artifacts derive from Site 2777. Two (2) of these are small coral files: one (1) is a tip fragment and the other, probably whole. A complete unbarbed shell fishhook (HT1a) and five (5) shell fishhook blanks (two [2] broken) comprise the remainder of the assemblage. The hook and hook blanks are small (their lengths range from 0.99 to 1.63 centimeters) and are probably derived from Isognomon spp. or Pinctada spp.

All these artifacts except the complete fishhook come from the entrance area (N1W3 and S1W3) within the Stratum II layer. The proximity of these artifacts to the small, limestone, cobble-filled hearth described above may indicate a functional correlation and clearly defines the entrance area as the focal point of fishhook production at this site. This whole fire blackened fishhook comes from Stratum II in N1W1 in the rear area of the structure interior and adjacent to the large stone-lined hearth described above) in S1W1. This suggests a different function for the interior hearth, that of food consumption.

The midden component of Stratum II, although occuring both in and outside the structure, is concentrated in a few areas. One very dense area is present in the southeast quadrant of S1W1 adjacent to the east edge of the interior hearth and the east wall. This concentration consists primarily of fish remains, and Stephanolepis spp. make up a large number of those individuals. The diagnostic multi-barbed dorsal spine is present throughout the Stratum II deposit but is most abundant in this concentration.

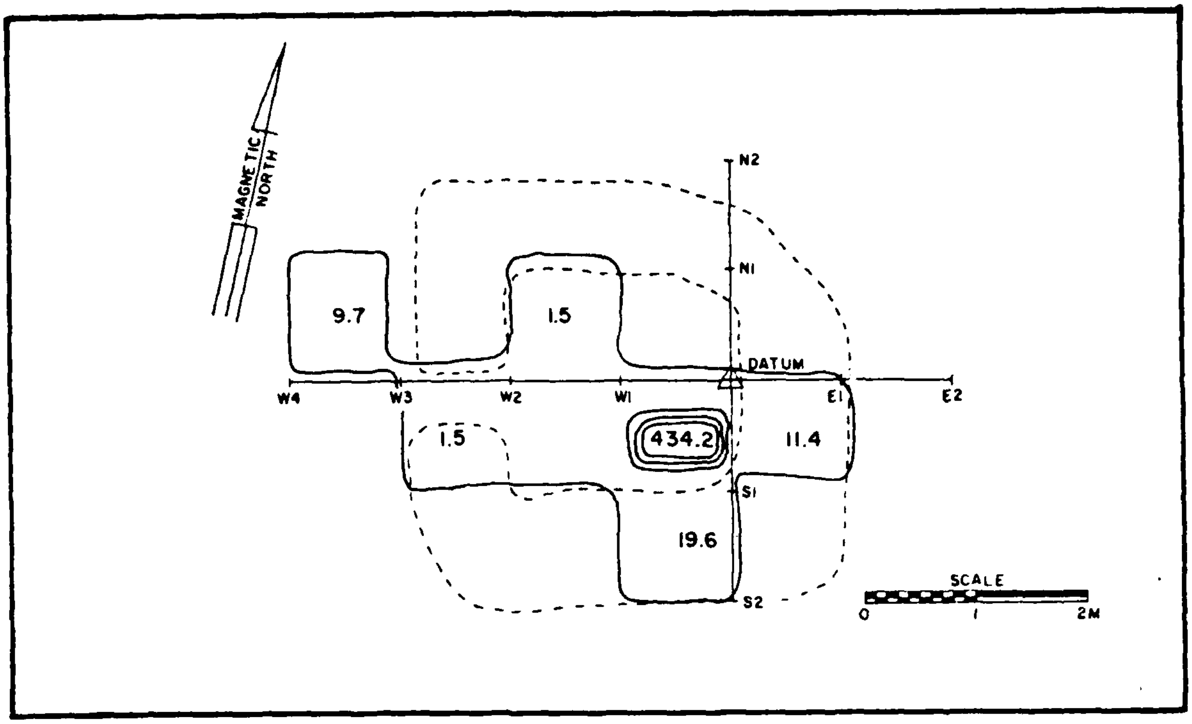


FIGURE 45 DENSITY CONTOURS (100 GRAM INTERVALS) OF MIDDEN WEIGHT. STRATUM I SITE 50-80-12-2777.

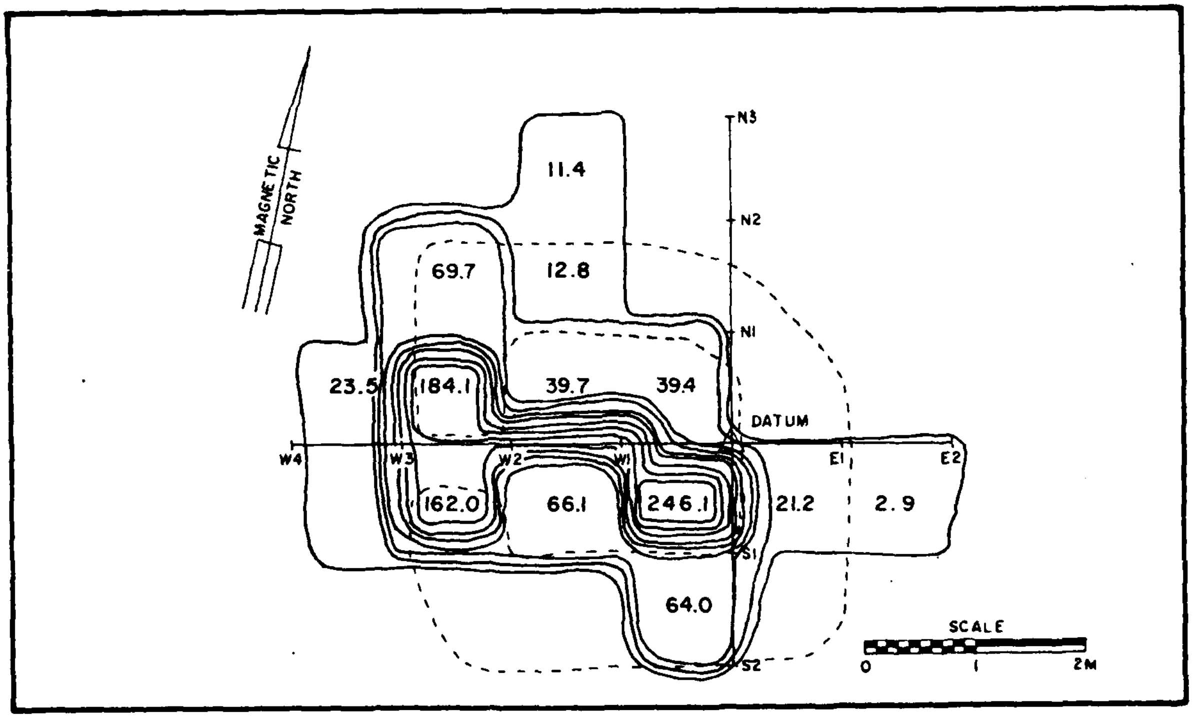


FIGURE 46 DENSITY CONTOURS (25 GRAM INTERVALS) OF MIDDEN WEIGHT. STRATUM II SITE 50-80-12-2777.

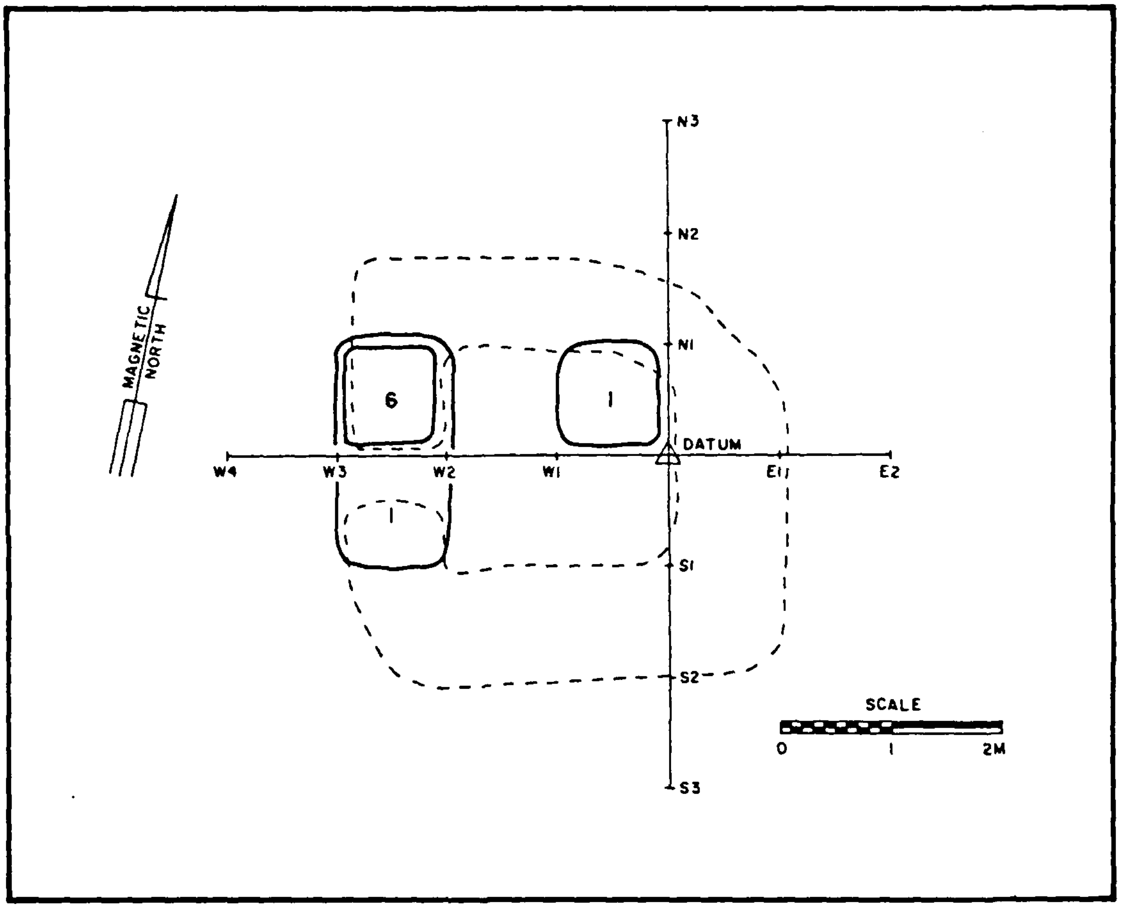


FIGURE 47 DENSITY CONTOURS OF ARTIFACTS (INTERVAL 5) BY FREQUENCY. STRATUM II, SITE 50-80-12- 2777.

A second concentration of fish bone midden derives from Layer II within the cupboard feature in the east wall. Since this midden is close to the interior hearth, it may be only an extension of the first concentration described. The fish remains recovered in the cupboard, however, probably derive from a different species (unidentified). Still, the high density of midden and the absence of artifactual material (except the complete fishhook) around the interior stone-lined hearth strongly suggest that this area was used for the preparation and consumption of food.

A third concentration of fish remains (in N1W3) is situated on the north side of the entrance in the interstices of the west wall foundation stones. The wrasse (hinalea) and parrot (uhu) fish families are represented by mouth parts, and numerous multi-barbed spines of Stephanolepis spp. are again present. Other midden constituents from this site are sea urchin, bivalves, and crustacea, with only occasional examples of univalves.

The data recovered during the excavations suggest this sequence of events at Site 2777:

1. Occupation indicated by an ash layer subsequently buried beneath the west wall on the north side of the entranceway.

2. Construction of the enclosure walls, delineation of the entrance, placement of the interior pavement, and probably the initial demarcation and use of the interior and exterior hearths. These activities are interpreted as contemporaneous based on stratigraphically defined relationships of the features to Stratums II and III, but their order of occurrence is not necessarily as stated here. Peak concentrations of midden and artifacts indicate intensive activity at the entrance of the site suggesting the previous existence of a specialized pole and thatch structure used primarily for storage of personal belongings and sleeping.

3. Subsequent use of the site by people who relied, at least partly, on the marine resources for subsistence. During this time, Stratum II and all associated cultural refuse were deposited at the site.

4. Abandonment of the site after an undetermined period of occupation and subsequent buildup of the recent A horizon.

Site 50-80-12-2778

Description

The U-shaped structure of Site 2778 consists of three (3) low, partially collapsed walls 40 to 60 centimeters high, of unequal length (Figure 48). The open, unwalled side is oriented roughly south but the longer east wall directs the entranceway or open side to the south-southeast. The wall foundations of this structure are formed by two parallel alignments 70 to 100 centimeters apart, comprised predominantly of upright limestone slab boulders, but with some stacked boulders, partially buried by the sediments present on this site. The cores of the walls between the foundation alignments are made by filling in the space with small boulders and cobbles in a loosely stacked pattern.

This structure encompasses an area of approximately 4 meters (north to south) by 3 meters (east to west), or 12 square meters of living space. The structural walls are presumed to have been capable of supporting a pole and thatch hale, but all evidence of post holes is obliterated.

A wide, shallow, sediment-filled sink is situated a few meters west of Site 2778. Numerous other sinks in the immediate vicinity contain little or no soil, and many of these have been utilized recently as rubbish pits.

The vegetative overstory in the area around Site 2778 is comprised of large kiawe trees (*Prosopis spp.*) (many of which retain scars of previous logging) in the least distrubed areas, and two to

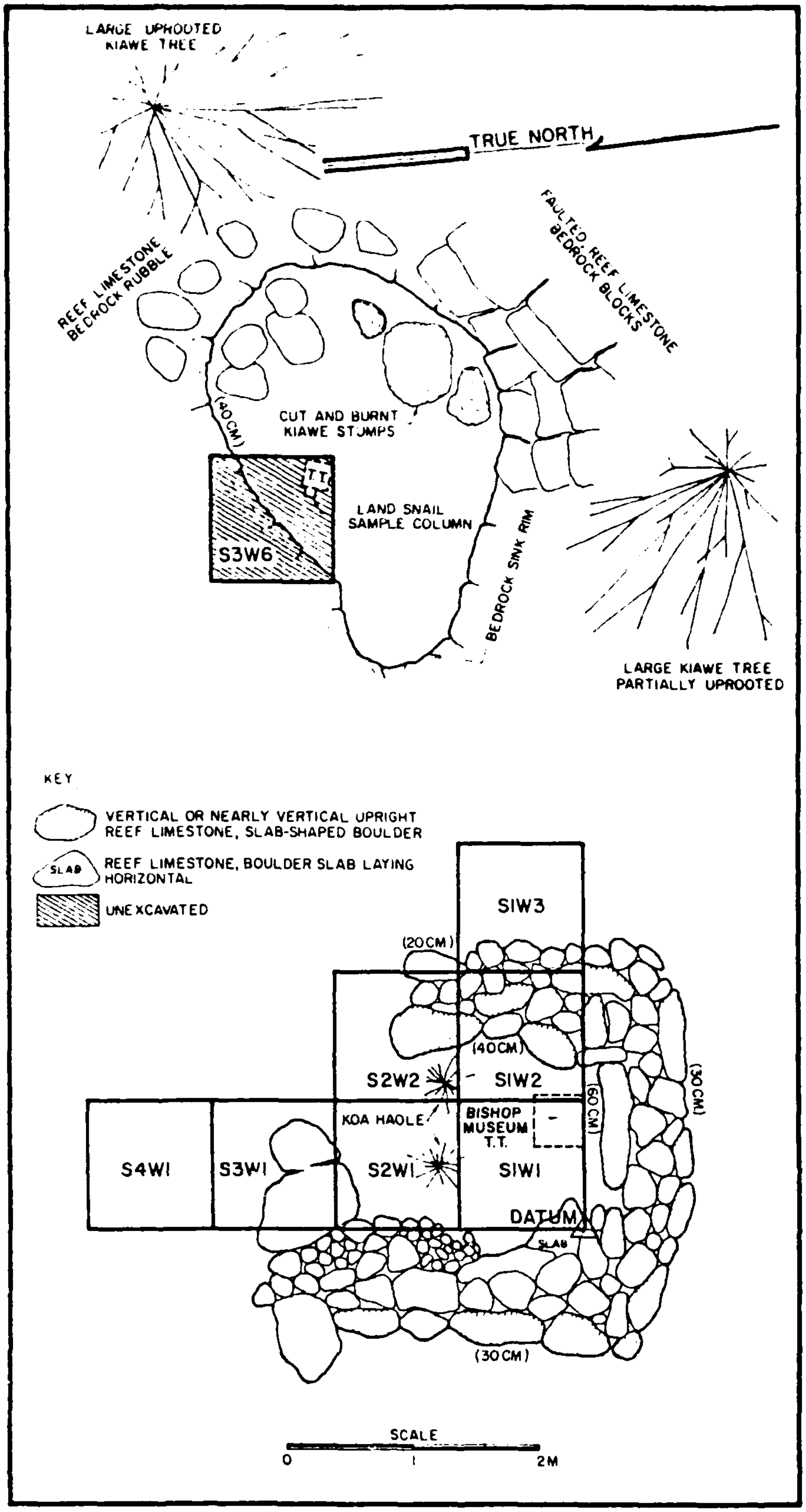


FIGURE 48 PLAN VIEW OF SITE 50-80-12-2778, SHOWING EXCAVATION GRID.

three-year old ekoa (Leucaena glauca), 15 to 20 feet tall, in more recently disturbed places. The understory is comprised predominantly of morning glory vines with 'ilima (Sida spp.) koko'olau (Bidens spp.) and various introduced weeds and grasses occuring in recently disturbed and clear areas.

Excavation Results

Excavation of 2778 consisted of, first, removal of the core filling in the structural walls to determine if remnant cupboards or other features were present. None were discerned. Next, the previous Bishop Museum's test trench was cleaned out and inspected. Then additional trenches were excavated in the enclosed interior of the site, through the west structural wall, and in the probable entranceway at the southwest end of the structure.

Four (4) stratigraphic units that can be distinquished from the excavations are described here, from the surface down.

UNIT I — Recent O and A1 horizon (10YR 2/2). The matrix is a fine, gravelly, cobbly silt loam, loosely compacted, with very weak, discontinuous cementation. Thickness ranges from less than 5 centimeters to 9 centimeters. The boundary is clear and wavy. Cultural material consists of a few shell fragments derived from mixing with Unit II below.

UNIT II — Prehistoric (?) A3 horizon (10YR 3/1 to 10YR 4/2). The matrix is fine, gravelly silt loam, loosely compacted and weakly cemented. The boundary is clear and wavy. Thickness ranges from 3 to 10 centimeters and reaches a maximum depth of 20 centimeters below the surface between the roots of an ekoa tree growing in the enclosed area of the site. This unit contains prehistoric (?) artifacts and midden material. The 10YR 3/1 component is concentrated in Trenches S1W1, S2W1, S1W2, and S2W2 (in the center of the site) and is less gravelly than the 10YR 4/2 component.

UNIT III C horizon (10YR 6/4 to 10YR 7/4). The matrix is fine gravelly silt loam, compact and weakly cemented. The boundary is abrupt and wavy. This discontinuous layer. Cultural material consists of a few shell fragments and fish bone present in the unit's upper 2 to 3 centimeters. Dense concentrations of land snail shells were present.

UNIT IV Reef limestone bedrock, containing fossilized shellfish remains.

Excavation trenches in the site's interior revealed a small hearth (55 centimeters average diameter) in Stratum II (in S2W1). This feature is ill defined near the surface due to charcoal-staining of the sediments around this feature. It is more sharply defined at 10 centimeters below surface where the lower limits of the hearth form a shallow, bowl-shaped pit intrusive into Unit III.

Midden and artifact density in the structure's interior in the hearth feature is generally sparse. No charcoal suitable for analysis was present in the hearth and midden was concentrated in the southeast quadrant of S3W1, near the southern limit of the site at the entrance (Figures 49 through 51). The excavation was extended another meter to the south (S4W1), where Unit II is also present, because of this midden concentration, but midden density decreases abruptly, comprising only of a few shell fragments.

The portable artifact assemblage consists of three (3) specimen, including a one-piece bone fishhook shank fragment (from S1W2, adjacent to the interior face of the west wall) and two (2) pieces of cut bone (from S3W1 and S2W2) deriving from Unit II.

Excavation of Trench S1, which extends from the site's interior through the west wall of the structure, demonstrates that the wall is

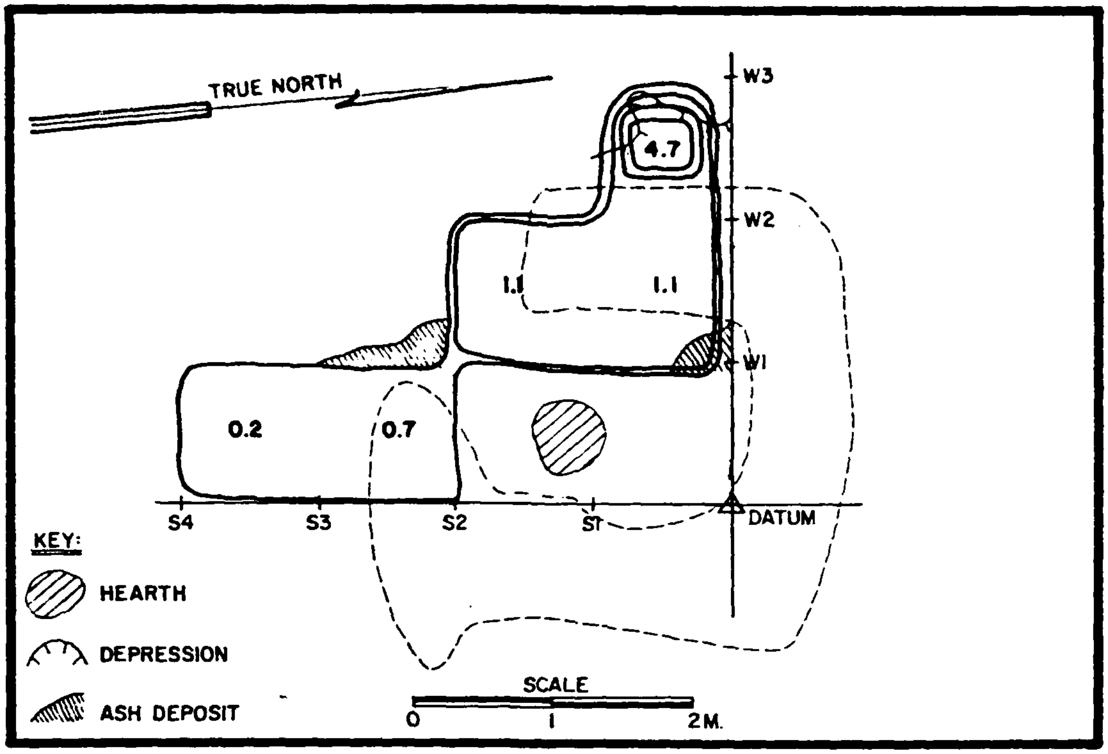


FIGURE 49
DENSITY CONTOURS(1 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM I
SITE 50-80-12-2778.

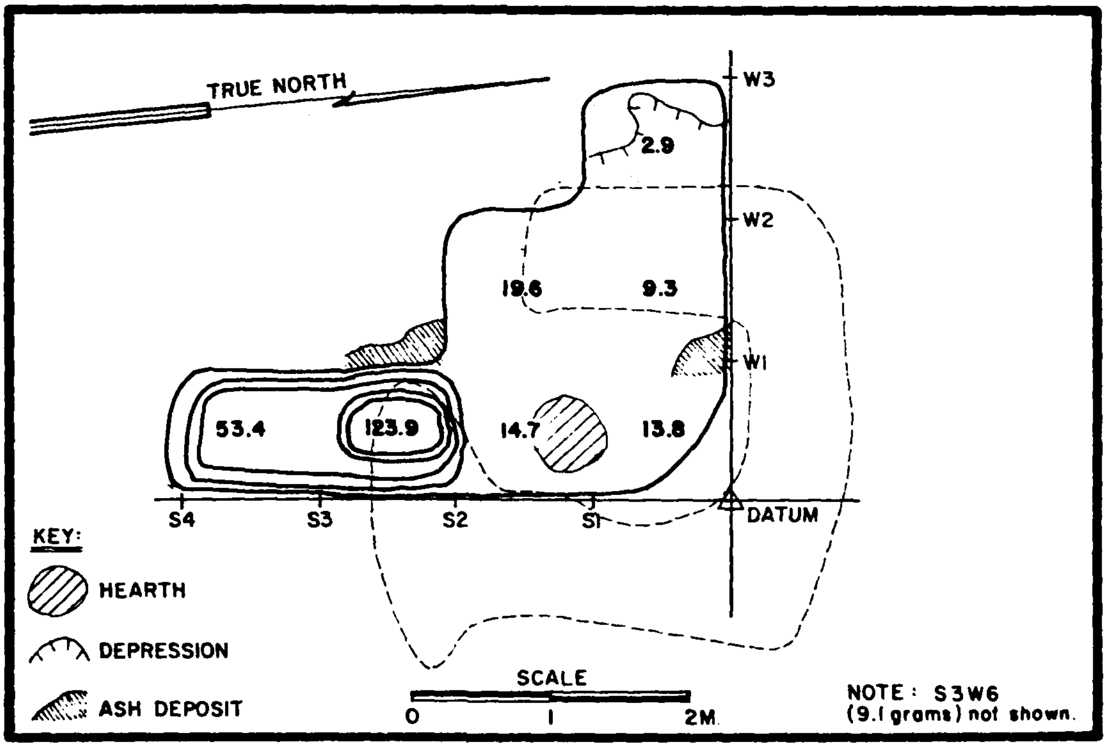


FIGURE 50
DENSITY CONTOURS(25 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM II
SITE 50-80-12-2778.

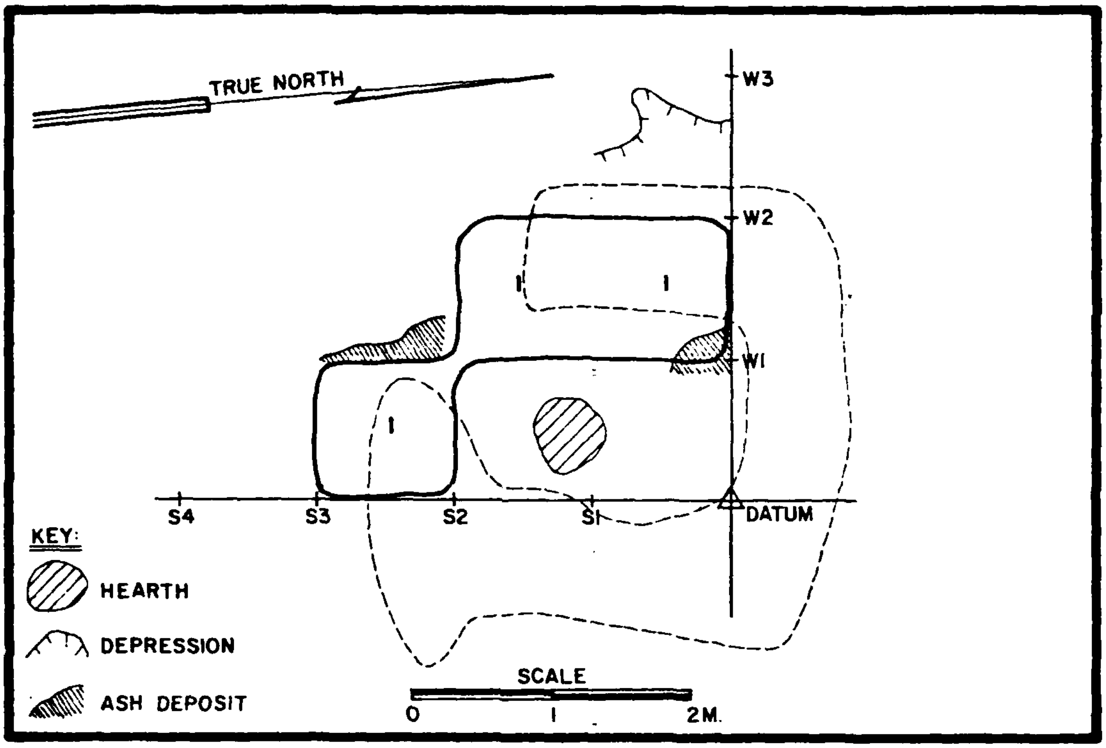


FIGURE 51
DENSITY CONTOURS(INTERVAL - 1) OF ARTIFACTS BY FREQUENCY, STRATUM II
SITE 50-80-12-2778 .

contemporaneous with Unit II. Upright foundation stones are set upon the surface of Unit III and, in one case, are set into a pit excavated into Unit III which is backfilled with the reworked Unit III matrix. Consequently, the cultural unit (II) partially buries and is confined by the wall foundations.

A 20-centimeter square trench was excavated to 40 centimeters below surface in the northwest quadrant of Trench S3W6 (situated in the sink adjacent to the west to determine whether significant densities of cultural midden or artifacts were present, to describe the strata present, and to collect a column sample for future land snail analysis. Middens were present in the excavated trench, but concentration was not dense. Burned bird bone fragments and splinters predominated and only a few shell fragments were present. No artifacts were present in this trench. A description of the five (5) soil layers encountered in Trench S3W6 follows, from topmost to lowest.

UNIT I Recent O and A1 horizons (10YR 2/2). The matrix is fine, gravelly, cobbly silt loam, loosely compacted with very weak, discontinuous cementation. The O horizon ranges from 10 to 30 centimeters thick. The A1 horizon has a fairly uniform thickness of 10 centimeters. This unit contains modern charcoal bits and pieces and chain-sawn, burned kiawe tree stumps (in original position). The boundary is clear and wavy.

UNIT II Very dark grey (10YR 3/1, moist). The matrix is gravelly silt loam, loosely compacted and very weakly cemented, with many fine roots and few medium roots. The boundary is abrupt and smooth. The unit contains cultural midden, birdbone, and land snail remains and is 6 to 9 centimeters thick.

UNIT III Dark brown (7.5YR 3/2), fine, gravelly silt loam, loosely compacted and very weakly cemented. Fine roots are common. The unit has an abrupt, smooth boundary.

UNIT IV Very dark brown (10YR 2/2). The silt loam matrix is very gravelly, loosely compacted and weakly cemented. Fine roots are common. The boundary is clear and smooth.

UNIT V Dark reddish-brown to dark-brown (5YR3/4, 10YR 3/3, moist) silt loam, very gravelly and compact. This unit continues below the vertical extent of excavation at 40 centimeters.

The column of eight (8) samples removed from the east profile (roughly 10 centimeters square by 40 centimeters deep and collected by arbitrary 5-centimeter levels) has been stored for further analysis.

Site 50-80-12-2780 and 2781

Description

Sites 2780 and 2781 (Figures 52 and 53) are rude alignments of limestone boulders probably associated with a recent squatter's shack situated a few meters southwest of the sites.

Site 2780 (roughly 1 by 2 meters) is formed on the east and west by slab-shaped limestone boulders lying flat upon bedrock and on the south by two partially uprooted kiawe trees (whose roots have helped form the feature) on the south. A rusted one-gallon size paint can with a pile of modern wire nails (not collected) beside it lay in the southeast portion of the feature, next to the kiawe tree.

Site 2781 is roughly 3 meters square. It is formed of slab-shaped boulders lying flat upon bedrock, with some smaller, polygonal boulders stacked (not more than two rocks high) between the larger slabs. A section of rusting, corrigated roofing iron was lying adjacent to the west side of the feature. Solution sinks to the west of the feature are boulder filled, and kiawe trees nearby bear the marks of previous logging activities. Solution sinks to the south of the feature around the squatter's shack are filled with recent historic rubbish.

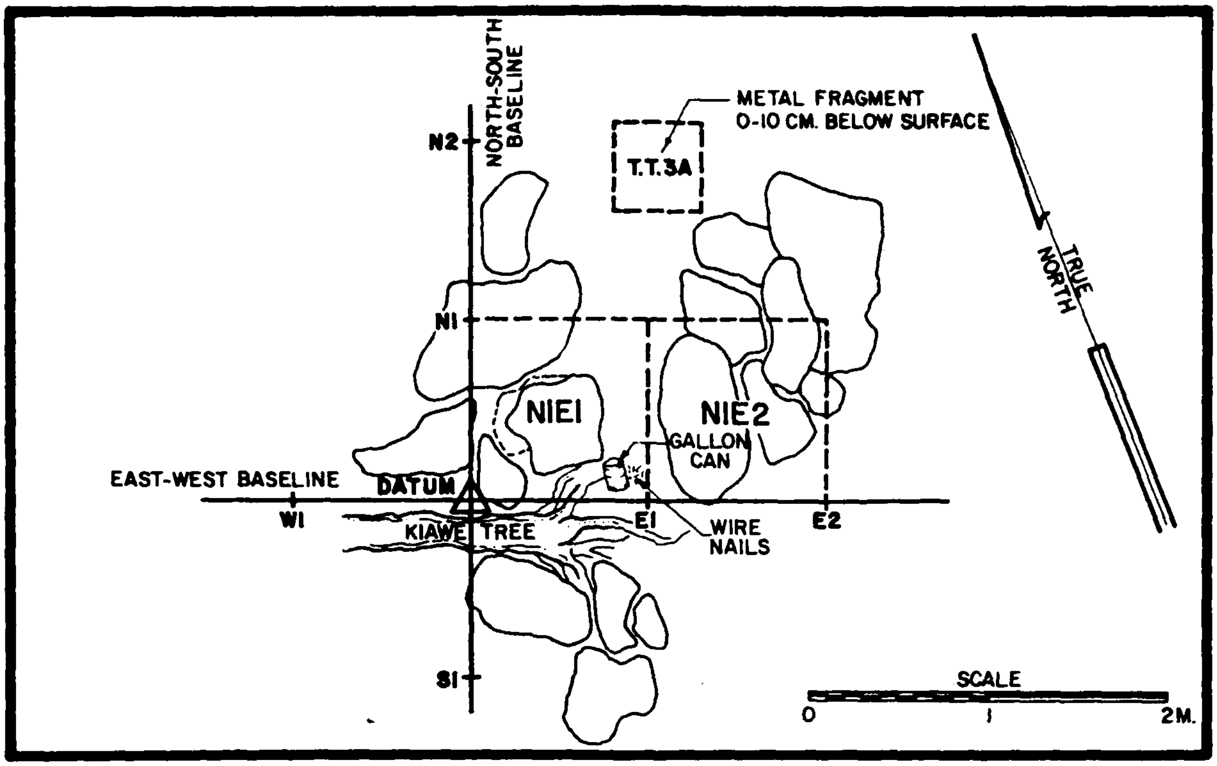


FIGURE 52 PLAN VIEW OF SITE 50-80-12-2780, SHOWING EXCAVATED TRENCHES.

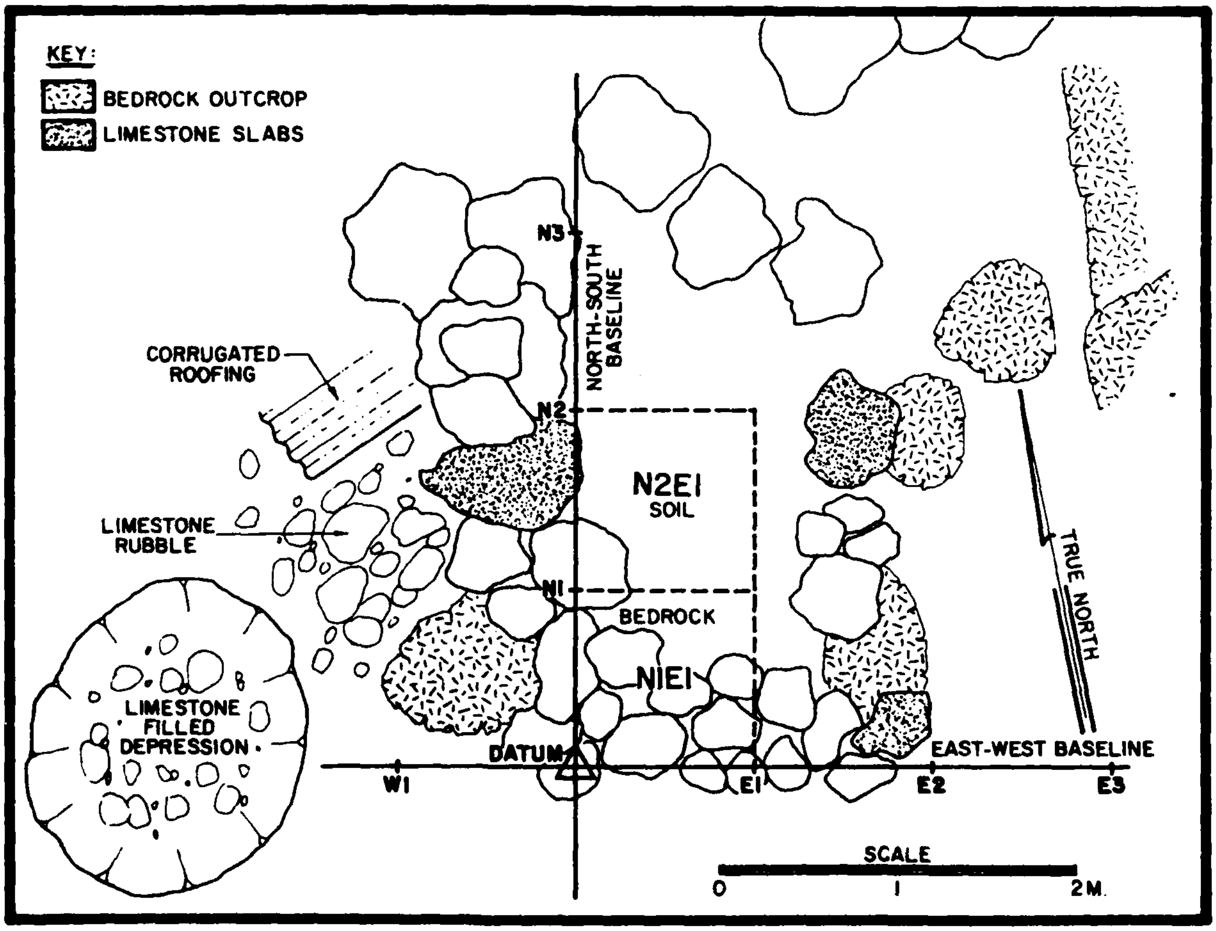


FIGURE 53 PLAN VIEW OF SITE 50-80-12-2781, SHOWING EXCAVATED TRENCHES.

Excavation Results

Salvage of these sites consisted of excavation of two (2) one-meter square trenches in each feature. In both sites, three (3) strata were present, as described next, from top to bottom.

UNIT I Recent O and A1 horizon (10YR 3/2) matrix; loose; no cementation. This discontinuous unit is interrupted by Unit III. The boundary is abrupt and wavy.

UNIT II C horizon (10YR 6/4). Fine silt loam is loosely compacted and weakly cemented. This discontinuous unit occurs in fissures and in shallow depressions in the bedrock surface. No cultural materials were found.

UNIT III Reef limestone bedrock.

No midden or prehistoric artifacts were uncovered in the excavations (except those historic materials mentioned above) and no stratified culture-bearing layer is present in or around either feature. Both 2780 and 2781 are of recent origin and have no significance in the writing of the prehistory of Kalaeloa, Honouliuli, 'Ewa, O'ahu.

Site 50-80-12-2784

Description

Site 2784 (Figure 54) is a natural solution sink measuring about 4 meters north to south by 2 meters east to west, with a maximum depth of 0.9 to 1.0 meters. A section of stacked boulder wall constructed in this sink reduces its size to 1.5 meters north to south by 2.0 meters east to west. The southernmost portion of the sink is partially filled with boulders. Thus the feature appears as an oval-shaped pit, bordered by a stacked reef limestone boulder wall.

Site 2784 is approximately equidistant from the recent squatter's shack to the south and Site 2777 to the northwest. However, surface cultural material of historic age in Site 2784 consists of a section of black, rubber hose (not collected) situated in the sink upon boulder rubble, derived from the partially collapsed perimeter walls, and a few rusty can fragments situated nearby. Unlike Site 2784, other sinks in this locality of recent historic use are filled with refuse of modern manufacture and none are modified beyond being filled. For these reasons there is a greater probability that Site 2784 is contemporaneous with Site 2777.

Excavation Results

Salvage of Site 2784 involved (1) drawing a scale map of the feature; (2) cleaning debris from a previous Bishop Museum test trench in the sink excavated in 1976 (Sinoto); (3) extracting a column sample for future analysis from the east sidewall of the Bishop Museum's test trench; and (4) excavating the remaining sediments.

Characteristics of the five (5) soil layers encountered are as follows (see also Figure 55):

UNIT I — Recent O and A1 horizon. The matrix is fine, gravelly, cobbly silt loam (10YR 2/1), with weak, discontinuous cementation. The O horizon overburden partially buries the boulder rubble derived from gravity fall of the perimeter wall and contains a recent historic artifact (section of rubber hose). This unit contains charcoal and partially burned wood fragments derived from recent burning of kiawe stumps. This unit is 16 to 18 centimeters thick, with a clear, wavy boundary.

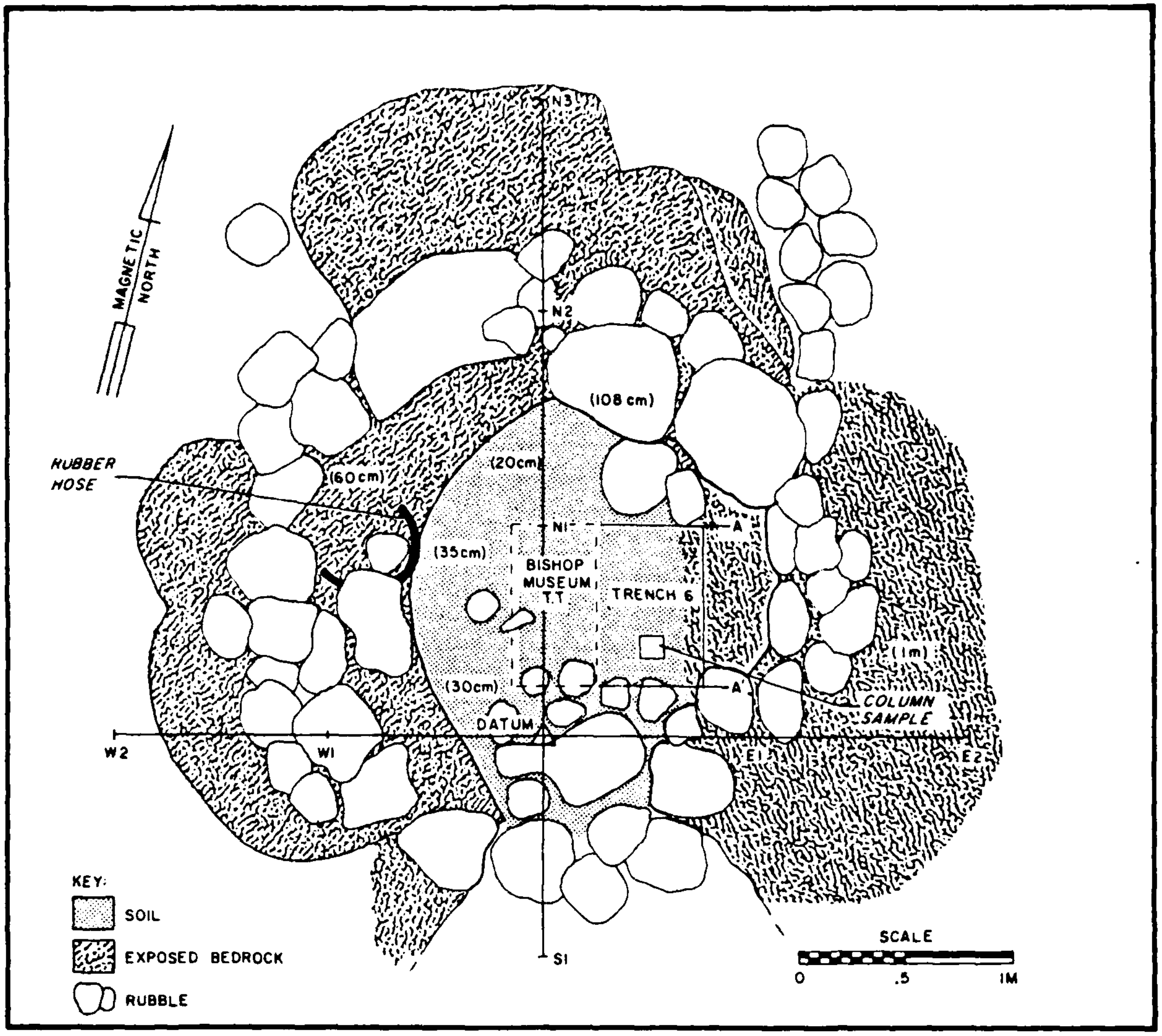


FIGURE 54 PLAN VIEW OF SITE 50-80-12- 2784, SHOWING EXCAVATION TRENCH.

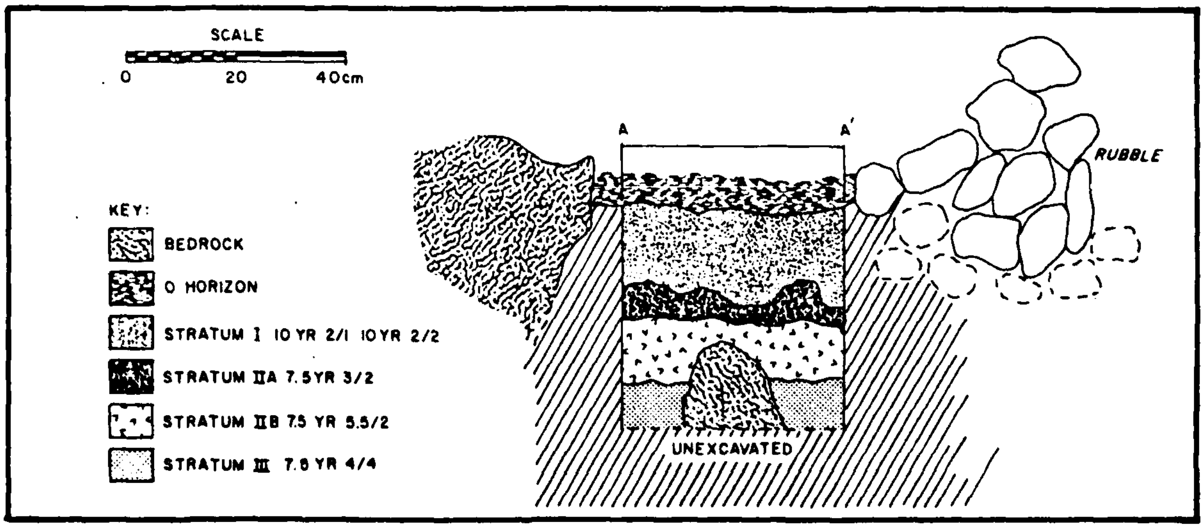


FIGURE 55 PROFILE OF THE EAST FACE OF EXCAVATED TRENCH. SITE 50-80-12- 2784.

UNIT IIA C (?) horizon (7.5 YR 3/2). The matrix is fine gravelly silt to silt loam, with compact, weak, discontinuous cementation, 2 to 8 centimeters thick. Gravels in the unit display graded bedding from very fine to medium as depth increases. The boundary of this discontinuous unit is clear and wavy.

UNIT IIB Prehistoric (?) A3 horizon (7.5 YR 5.5/2). The matrix is fine, gravelly silt loam, compact with weak, continuous cementation. Few cobbles and few large roots and many fine roots are present. Thickness ranges from 8 to 12 centimeters. This unit is discontinuous, interrupted by irregularities of bedrock. The boundary is clear and wavy. Bird bone is present but sparse.

UNIT III C2 horizon; fine, gravelly silt loam (7.5YR 4/4). This discontinuous unit occurs in smaller pits in the sink bottom. The boundary is abrupt and wavy to irregular. Bird bone present is sparse.

UNIT IV Reef limestone bedrock.

No buried cultural material was present in the sidewalls of the Bishop Museum's trench, nor were any cultural materials observed when the column sample was collected. The remaining sediments were excavated and screened but no cultural materials were present.

The column sample was excavated by arbitrary 5-centimeter levels measured from the surface of sediments in the sink. A differential volume between samples is inherent.

Site 50-80-12-2786

Description

Site 2786 is a roughly triangular-shaped enclosure 4.5 by 7 meters in size (Figure 56). The east wall of the enclosure ranges from 40 to 70 centimeters in height and has a maximum width of 130 centimeters. This wall is constructed with small-sized boulders and cobbles in the core-fill construction style, utilizing upright slab boulders along the interior face. The north wall forms the base of the triangle and is of stacked-boulder construction, interlocking with the north end of the east wall. In a state of collapse, the north wall is irregular in height (maximum, 45 centimeters) and 1 meter or less in width.

The west wall contains a cupboard feature at the northwest corner of the enclosure. The entrance of the site is situated in the middle of the west wall (south of the cupboard). The width of this wall ranges from 60 centimeters in the south extreme to 1.5 meters at the north. The cupboard feature incorporated into the north end of this wall is a large feature, utilizing a slab shaped capstone and polygonal-shaped boulder walls. This cupboard space is bordered on the south by a short (1.5-meter) segment of core fill wall with upright slab exterior faces with small boulder fill, on the west by uprights forming the exterior face of the enclosure at the northwest corner, and on the north by the north wall of the enclosure at the northwest corner. The cupboard is open to the east (i.e., the enclosure's interior). It is 30 to 35 centimeters wide by 35 centimeters high with a roughly 60-centimeter horizontal depth. This cupboard feature is very disturbed, possibly from natural settling or recent human disturbance.

Excavation Results

Eight (8) one-meter square trenches were excavated in the enclosure interior and beneath the west wall to reveal the presence of five (5) stratigraphic layers.

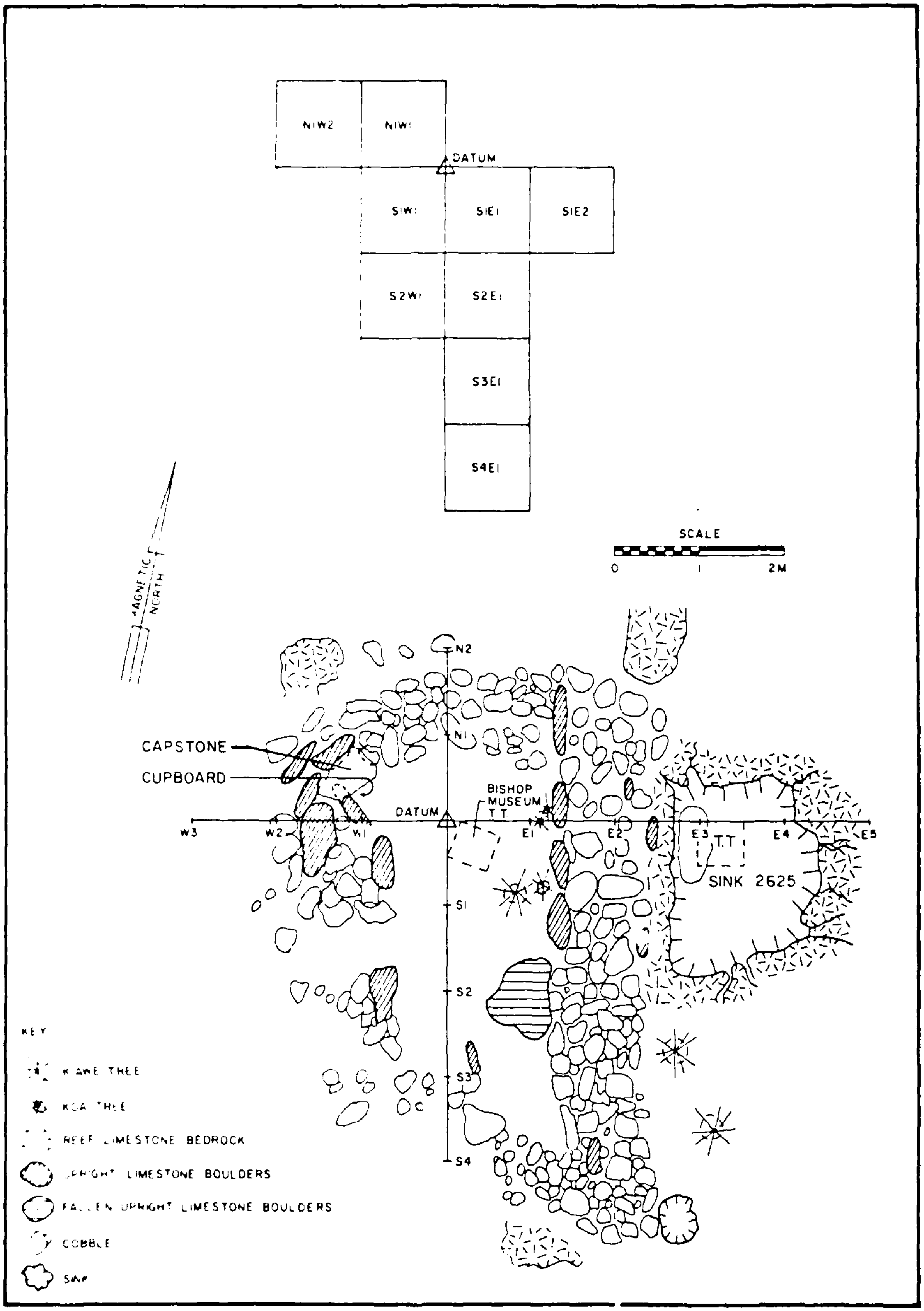


FIGURE 56 PLAN VIEW OF SITE 50-80-12-2786, SHOWING EXCAVATION GRID.

UNIT I — The black (10YR 2/1) matrix (O and A1 horizons) is fine silt loam, high in organic matter, loose to loosely compacted, with many fine roots and weak, discontinuous cementation. Thickness ranges from less than 1 centimeter to 7 centimeters. The boundary is clear and wavy. The sparse scatter of Nerita shells in this unit probably results from reworking of Stratum II and filtering of material in the wall.

UNIT II — A3 horizon. The matrix is very dark grey (10YR 3/1), fine, very gravelly sandy loam. Many fine roots are present and coarse roots are common. This unit is compact, with continuous, weak cementation. Thickness ranges from 4 to 10 centimeters and may exceed 10 centimeters under trees. The boundary is clear and wavy. The unit contains cultural midden.

UNIT IIA — The brown to yellowish brown (7.5YR 5.5/4 10YR 5/4) matrix is fine, gravelly, loamy sand, with few fine and coarse roots. This unit is very compact, with weak, continuous cementation. Thickness ranges from 1 to 6/7 centimeters. The lower boundary is clear and wavy. This is a transitional layer of reworked Stratum III between Stratum III and Stratum II. A few shellfish remains are present.

UNIT III — Pink (7.5YR 7.5/4) matrix of fine, gravelly, sandy loam, with roots few to common. This is a compact, discontinuous unit with weak, continuous cementation and it ranges in thickness from zero (0) to more than 10 centimeters in some places. The boundary is clear and wavy.

UNIT IV Reef limestone bedrock.

Distribution of cultural material within these strata summarized in Figures 57 and 58 is discussed next.

Excavation of Unit I revealed a fair amount of shell midden. Midden consisted of Nerita picea, Isognomon, Tellina, Cypraea, Turbo, Drupa, echinoderms, and charcoal. This material is concentrated inside the enclosure south of the entrance. Two (2) artifacts, a triangular sandstone abrader and a small discoidal, eroded 'ulu maika were found just behind the interior face (an upright slab) in the west wall.

Unit II contained larger quantities of shell and charcoal, including Conus and Periglypta in addition to the genera mentioned above. Limestone gravel and fossilized shell (particularly Cypraea) increase with depth and midden is absent below 20 centimeters. Midden in Unit III, when present, appears only in the uppermost 2 to 3 centimeters.

Excavation of the trenches through the interior of the enclosure showed initial occupation occurring upon the Unit III surface of reef limestone bedrock and windblown silt. Deposition of Unit I and II may be a result of temporary occupation, however, the presence of midden 20 centimeters below the present surface and in contact with Stratum III suggests that this site was occupied for more than a brief time span. A specialized function for this site may be indicated.

Adjacent to 2786 are two (2) sinks. In 2625, (Sink 1) a 50-centimeter square trench was excavated to 40 centimeters below the surface to determine the presence or absence of cultural midden or artifacts and also to collect a column sample for future land snail or other analysis. A 10-centimeter square column sample was taken at five (5) increments not of the same volume so samples would not cross stratigraphic boundaries. No artifacts or shell midden were found from this trench. Descriptions of the three (3) stratified layers are given below, from surface to lowest.

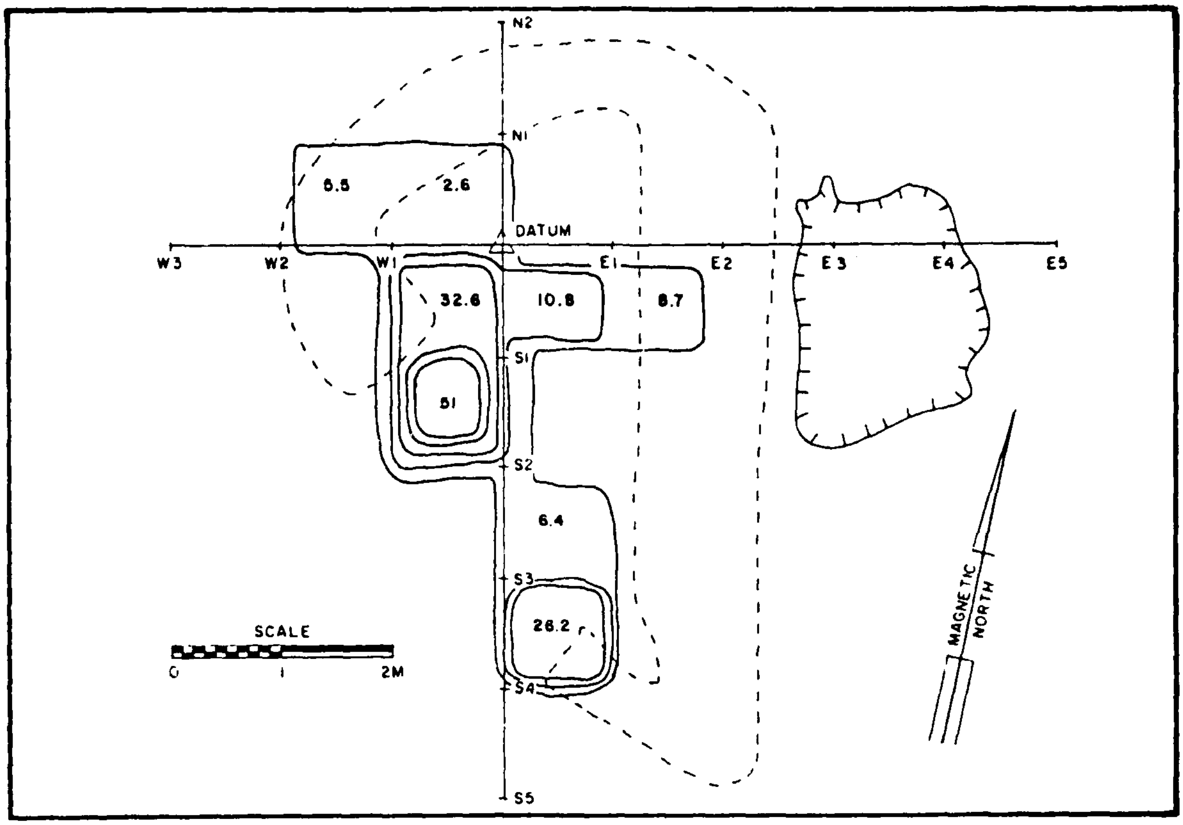


FIGURE 57 DENSITY CONTOURS (10 GRAM INTERVALS) OF MIDDEN WEIGHT. STRATUM I, SITE 50-80-12-2786.

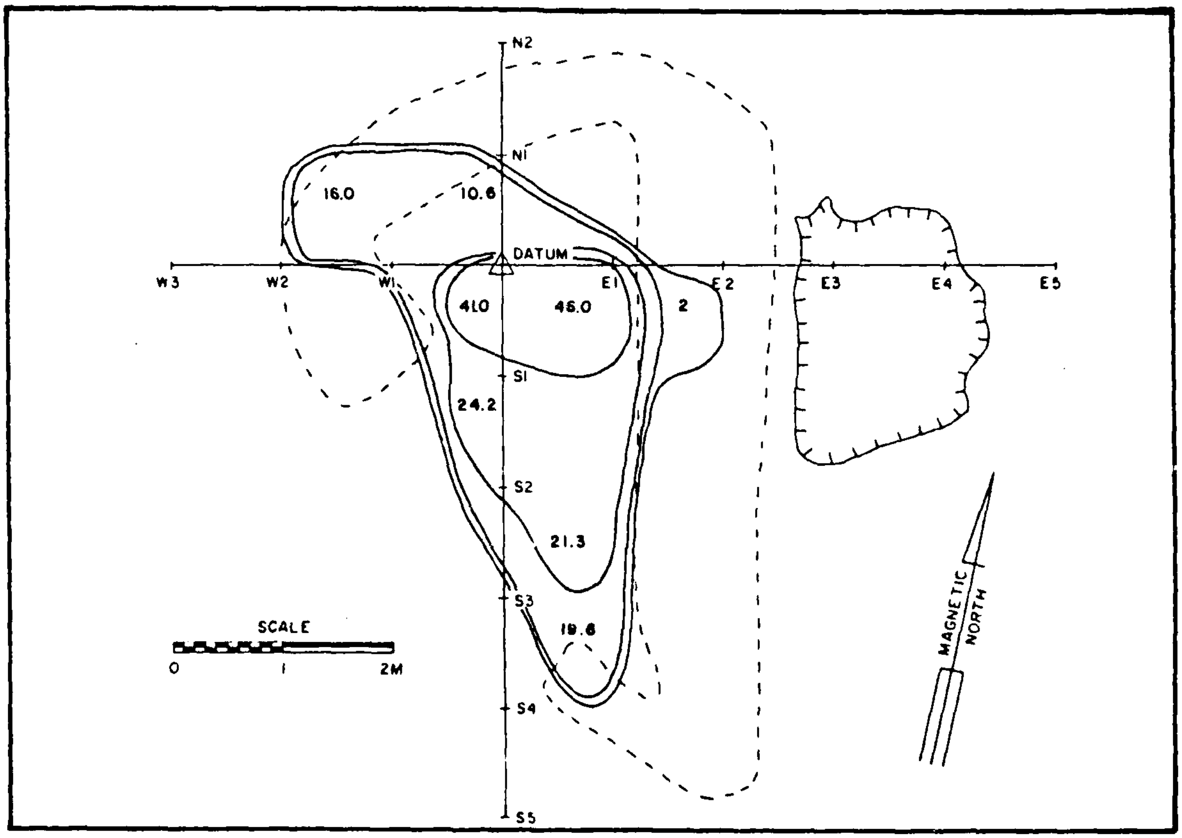


FIGURE 58 DENSITY CONTOURS (10 GRAM INTERVALS) OF MIDDEN WEIGHT. STRATUM II, SITE 50-80-12-2786.

UNIT I   A1 horizon; gravelly, loose silt loam, 3 to 10 centimeters thick. The boundary is abrupt and wavy.

UNIT II   Compact, fine, gravelly, silt loam (gravel is well sorted); coarse gravel decreases with depth (7.5YR 4/2). Roots are common.

UNIT III   C horizon. Sandy loam matrix 10 yr 4/6. Not excavated.

Site 2626 (Sink 2). A 50-centimeter square trench was excavated to 33 centimeters below surface in the northwest quadrant of 2626 to determine the presence or absence of cultural midden or artifacts and to collect a column sample for future landsnail or other analysis. A 10-centimeter column sample was taken at five (5) increments not of the same volume so samples would not cross stratigraphic boundaries. Charcoal flecks were found in Unit II although no shell midden or artifacts were present in this trench. A description of the three (3) soil layers encountered in 2626 (Sink 2) is provided next, from surface to lowest.

UNIT I   Organic litter; gravelly loose silt loam, 3 to 10 centimeters thick. The boundary is abrupt and wavy.

UNIT II   A3 horizon; very gravelly sandy loam. This unit grades to fine, sandy loam and darkens with depth. Roots are common. The boundary is abrupt and wavy. Charcoal flecks are present. The 10YR 3/2 changes gradually to 10YR 3/1 with increasing depth. Characteristics of this unit indicate that the sink was utilized as a hearth or possibly that hearth material was dumped here from hearths elsewhere.

UNIT III   C horizon; sandy loam, 10YR 4/6. The unit continues more than 33 centimeters below surface.

Site 50-80-12-2787

Description

The above-ground structural component of Site 2787 (Figure 59) comprises a fairly large rectangular to oval-shaped enclosure, with its long axis oriented east to west. The interior area excompassed by the structure is approximately 5 square meters (or 54 square feet). The west and south walls of the structure are in a state of collapse appearing as low sloping rubble mounds less than 50 centimeters high. The northeast part of the structure, however, is in a good state of preservation, measuring roughly 70 centimeters high and is constructed of horizontally stacked slab-shaped limestone and sandstone boulder faces with core fill. This construction style is unusual; most of the sites in the study area are constructed with stacked polygonal-shaped boulders mixed with slab-shaped boulders placed in an upright position. The horizontal stacked slab construction style of Site 2787 may indicate more recent rebuilding of that part of the structure.

A large kiawe tree rooted in the south wall has disturbed the enclosure's structural foundations in its vicinity obscuring what was probably the former entranceway. Outside the south wall, the ground surface is depressed and appears as a constructed boulder pavement extending 2 or 3 meters south, towards Site 2710-5 situated a few meters away.

The area surrounding this site has an extensive complex of sink-holes; three (3) were investigated because they possess characteristics of suitability for use as planting enclosures (pākanu) or plots. These three (3) sinks extend from Site 2786 to 2787 and only the sink closest to Site 2787 is discussed here. That sink adjacent to the north side of Site 2787 is hereafter referred to as Site 2710-S3 (Sink 3).

Sink 2710-S3 has a wide opening (from 1.5 to 2.5 meters wide) and is 4 meters long. It contains sediments but is relatively deep. The distance from the exterior ground surface to the top of the sediments contained in the sink ranges from 1.25 to 2 meters.

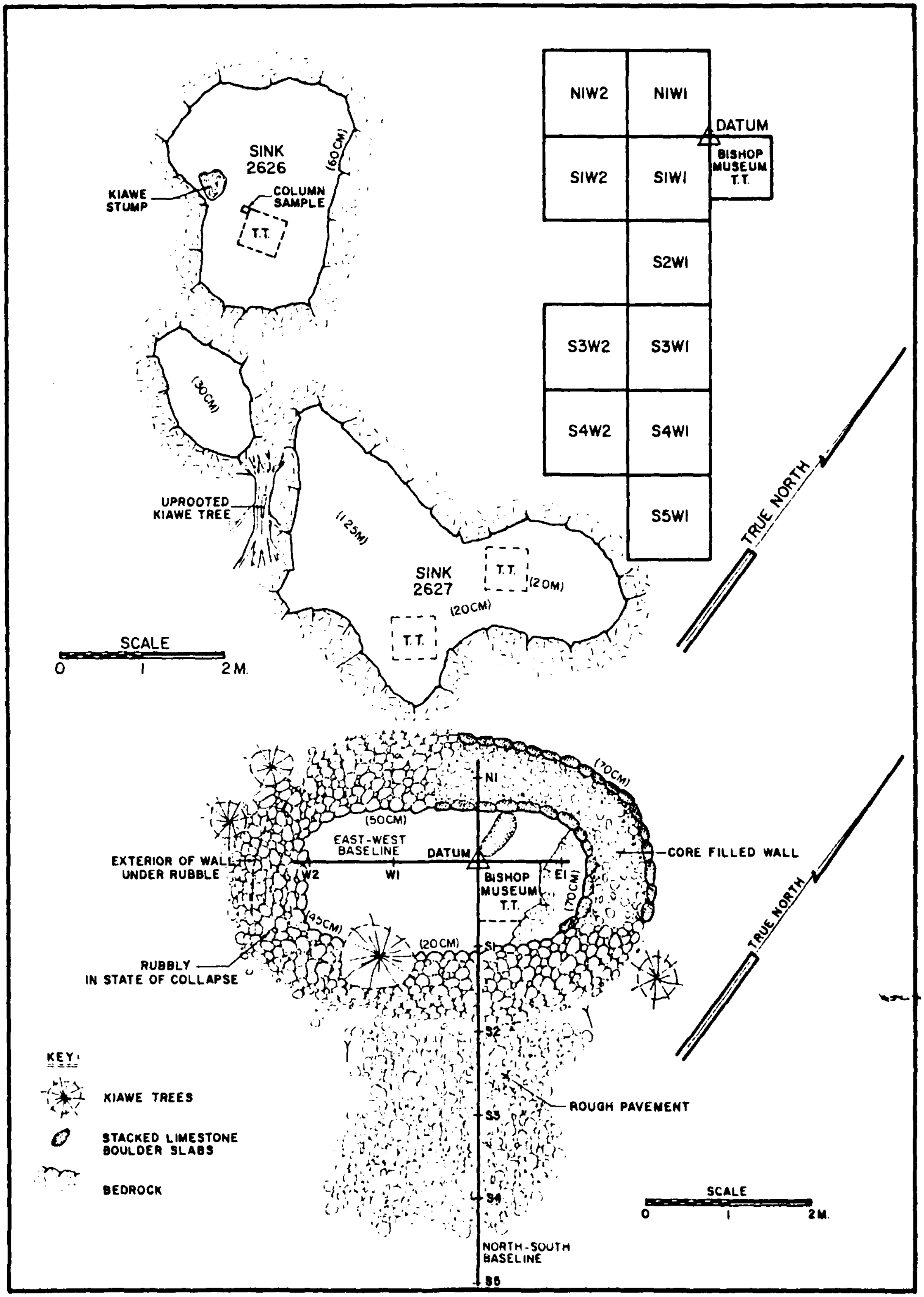


FIGURE 59 PLAN VIEW OF SITE 50-80-12-2787, SHOWING EXCAVATION GRID

Excavation Results

Two (2) specific areas of Site 2787 were selected for initial excavations; the area enclosed by the structure and the depressed area situated immediately south of the structure adjacent to or in front of the suggested entranceway. In both instances, the excavations were expanded around these foci and eventually were connected to provide a cross-section of the site.

A trench previously excavated by Sinoto 1976 is situated in the eastern portion ot the site's interior where a disproportional amount of bedrock is exposed on the surface. Therefore, the present excavations were concentrated in the central and west portions of the interior area where most of the stratified sediments occur. These sediment layers are described below from uppermost to lowest.

UNIT I — Recent O and A1 horizon; matrix of fine, very gravelly, cobbly silt loam (10YR 2/1), loosely compacted, with discontinuous, very weak cementation. Shell fragments occur occasionally. Thickness ranges from 2 to 9 centimeters increasing to 10 to 20 centimeters thick in the boulder pavement fill outside the structure. The boundary is clear and wavy.

UNIT II — Prehistoric (?) A3 horizon (10YR 3/2 10 YR 3/1). The matrix is fine, gravelly, cobbly silt loam. Boulders are common and serve as constructional materials forming the exterior pavement. Cementation is weak and continuous except in interstices between boulders. Portable and nonportable artifacts and organic midden are present. Thickness ranges from less than 2 to 43 centimeters in the structure's interior and from 65 to 100 centimeters outside of the structure. Roots are abundant.

UNIT III C Horizon (7.5YR 6/4 10YR 6/4). The matrix is fine, gravelly sandy loam; roots are few to common. The unit is compact, weakly cemented, and continuous. Thickness ranges from less than 1 to more than 10 centimeters. The boundary is abrupt wavy to irregular.

UNIT IV Reef limstone bedrock. Fossilized shells are predominantly Cypraea and Tellina.

Densities of midden and artifacts are shown in Figures 60 through 63.

Excavation of Stratum I produced midden material and portable artifacts. In both cases, concentrations in Unit I reflect concentrations within the underlying A3 horizon (Unit II) and are situated precisely in the places in the site where disturbance of the strata by large kiawe trees is greatest (at the northwest corner of the structure and in the probable entranceway) and where mixing is most prevalent (on the boulder pavement outside the structure). No nonportable artifacts are present in Unit I within the excavations.

Stratum II of Site 2787 contains significant quantities of portable artifacts and midden and is contemporaneous with nonportable artifacts that constitute the structural components (i.e., the enclosure walls and boulder pavement fill) of the site, including an extensive hearth area in the enclosure interior.

The hearth appears to occupy the central and western portion of the site's interior at the surface of Stratum II. However, at 5 to 10 centimeters below the surface of Stratum II, definition of the hearth is better. It is also apparent at this level that the hearth area contains evidence of more than one occurance. The broader hearth area is bounded on the north and west by near vertical bedrock occurring in Trench S1W2 and N1W2 and is bounded on the south and east by boulder and cobble fill which forms the lanai pavement outside the site and levels the floor of the east portion of the site's interior. Thus, the hearth area is centered in Trench S1W1, the south-central portion

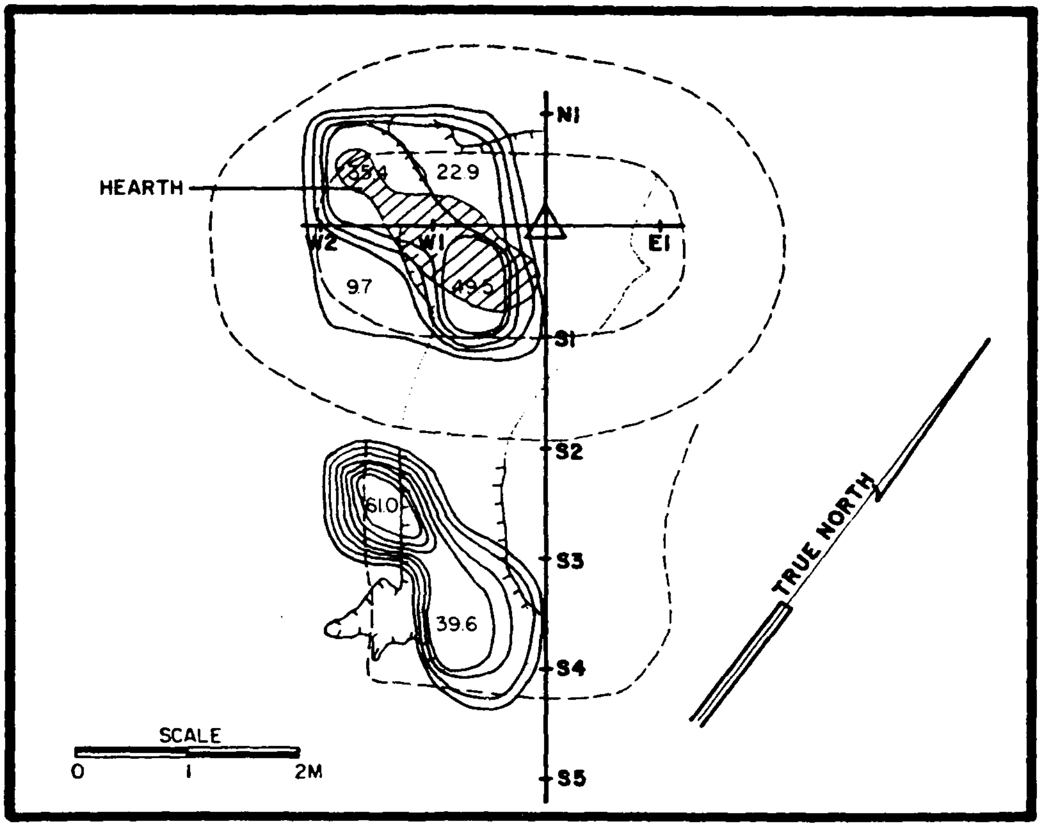


FIGURE 60 DENSITY CONTOURS(10 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM I
SITE 50-80-12-2787

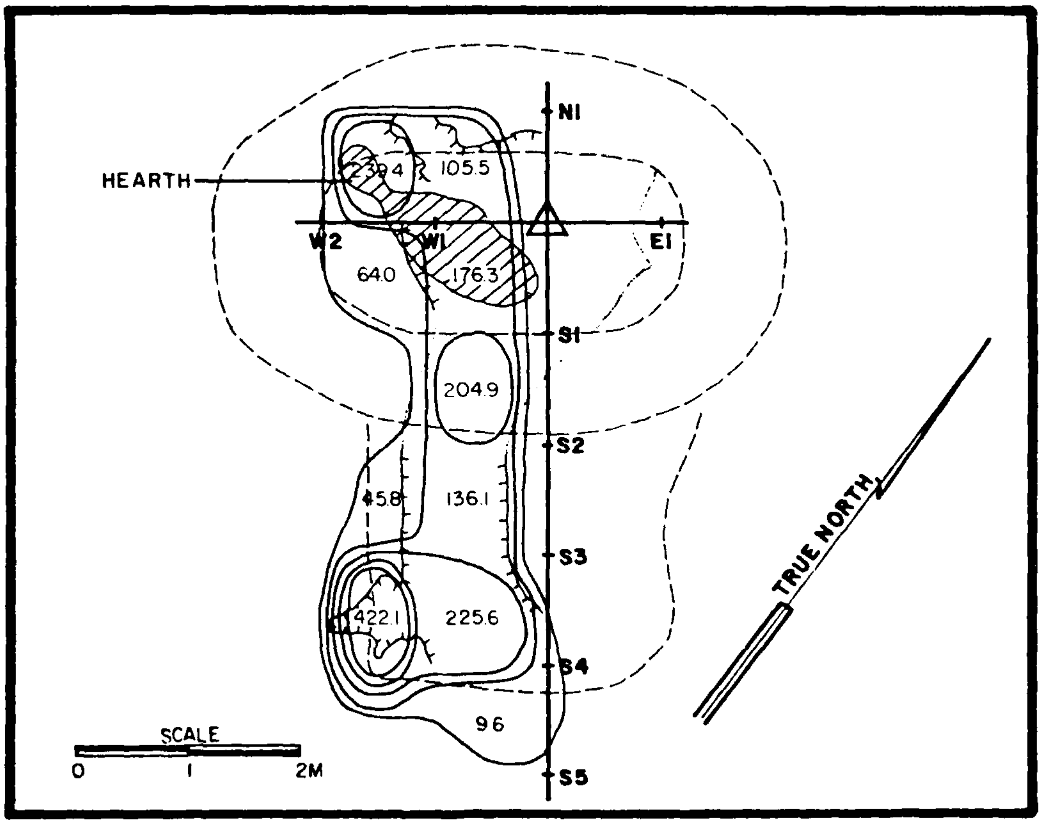


FIGURE 61 DENSITY CONTOURS(100 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM II
SITE 50-80-12-2787

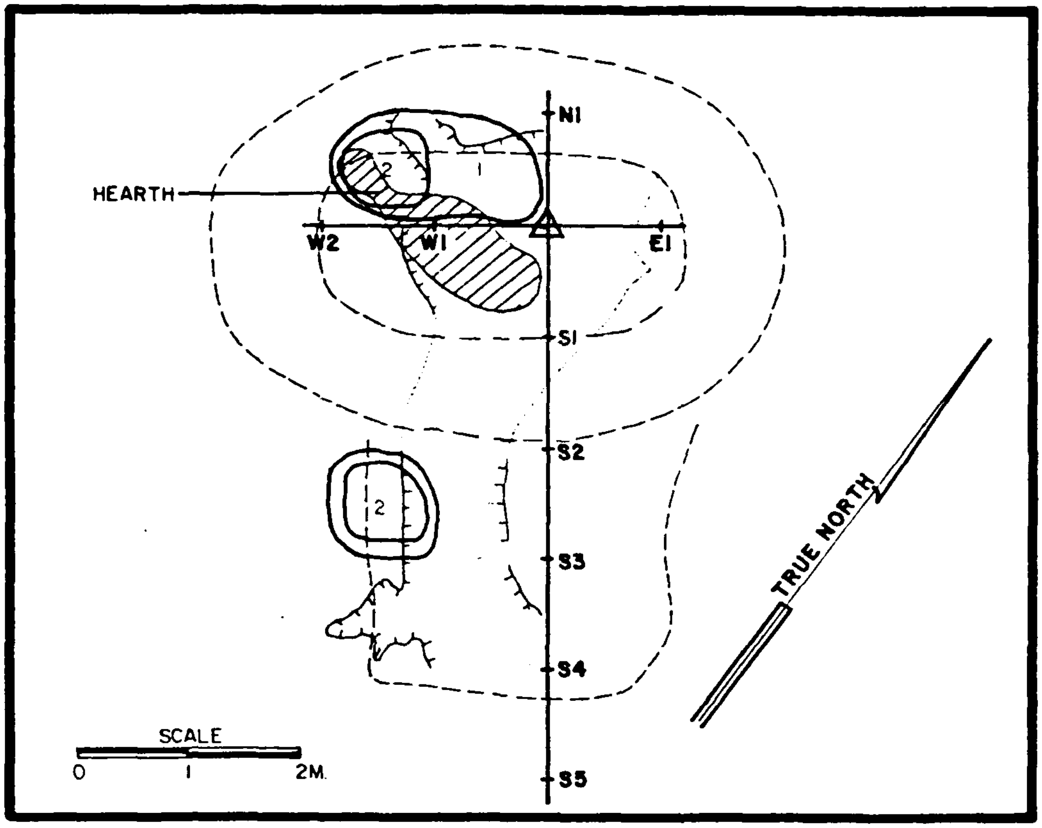


FIGURE 62 DENSITY CONTOURS OF ARTIFACTS(INTERVAL - 1) BY FREQUENCY, STRATUM I SITE 50-80-12-2787.

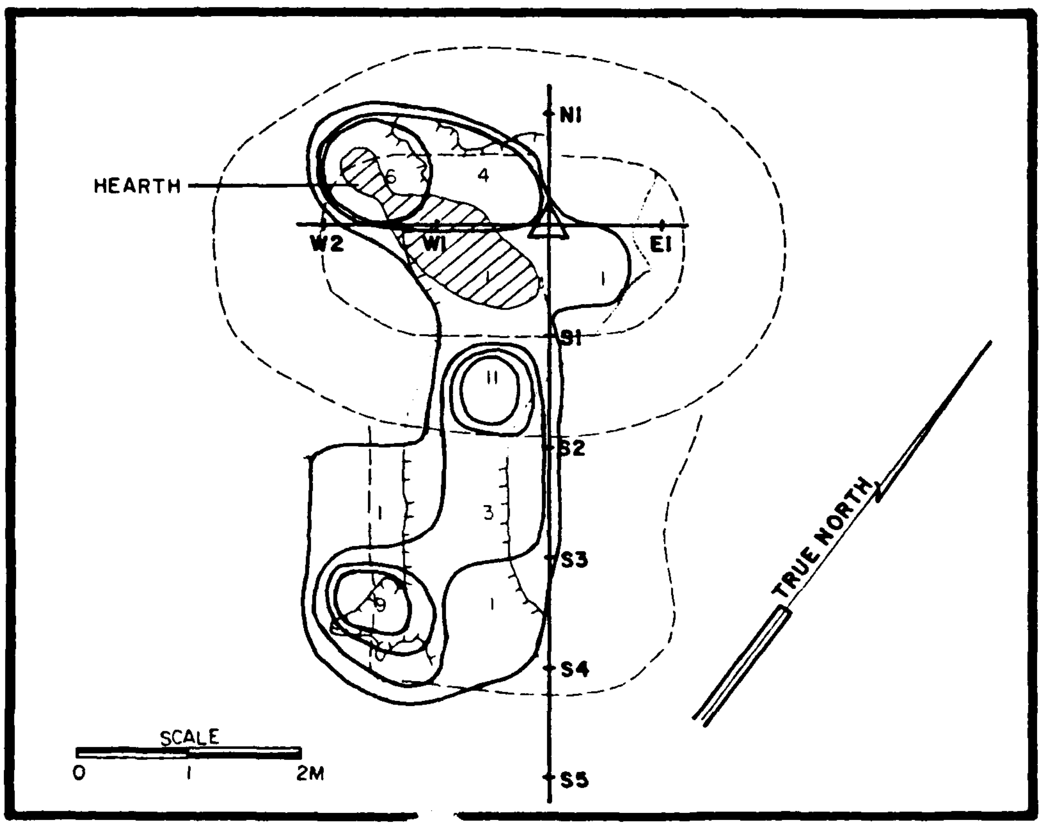


FIGURE 63 DENSITY CONTOURS OF ARTIFACTS(INTERVAL - 3) BY FREQUENCY, STRATUM II SITE 50-80-12-2787.

of the site's interior. Within this hearth area, at about 10 centimeters below Stratum II surface, a smaller semicircular alignment of limestone cobbles (30 centimeters in diameter) represents a single or short-term event within the longer time span of the hearth feature as a whole. The broader hearth area continues to a depth of 68 centimeters and the lower bowl-shaped portion intrudes into Stratum III. Concentrations of portable artifacts and midden within Stratum II can be discerned in the lanai area south of the structure and around the interior hearth.

Site 2787, together with Sink Site 2790, Site 2786, and 2625, 2626, and 2627, probably represent a traditional habitation compound (kauhale) (see Figure 3). Contemporaneous and intensive occupation of sites is indicated in Sites 2787 and 2790 where similar assemblages of portable artifacts and cultural midden are evidence for contemporaneity. Site 2787 probably functioned as a sleeping house, Sink 2626 as an outside hearth, and 2625 and 2627 as horticultural plots based on the occurrence of fine textured deposits in the sinks. A previously unrecorded wet sink nearby probably provided the inhabitants of the above sites with drinking, bathing, and irrigation water.

Site 50-80-12-2789

Description

Site 2789 is a roughly rectangular-shaped enclosure with an interior area of approximately 4 square meters (see Figure 64). The walls are constructed in the core-fill style, utilizing upright limestone boulder-sized slabs as foundation stones along the interior north, east, and south wall faces and the north and east exterior wall faces. Heights of these partially collapsed walls range from 30 to 60 centimeters. The west wall consists of a sparse scatter of limestone boulders around the entrance into the enclosure. Surrounding the site are areas of exposed reef limestone bedrock.

A single interior hearth feature measuring 50 by 55 centimeters is centrally located in the enclosure's interior. A preliminary test trench, 40 by 40 centimeters, exposed this charcoal-stained hearth layer assoicated with the A3 horizon.

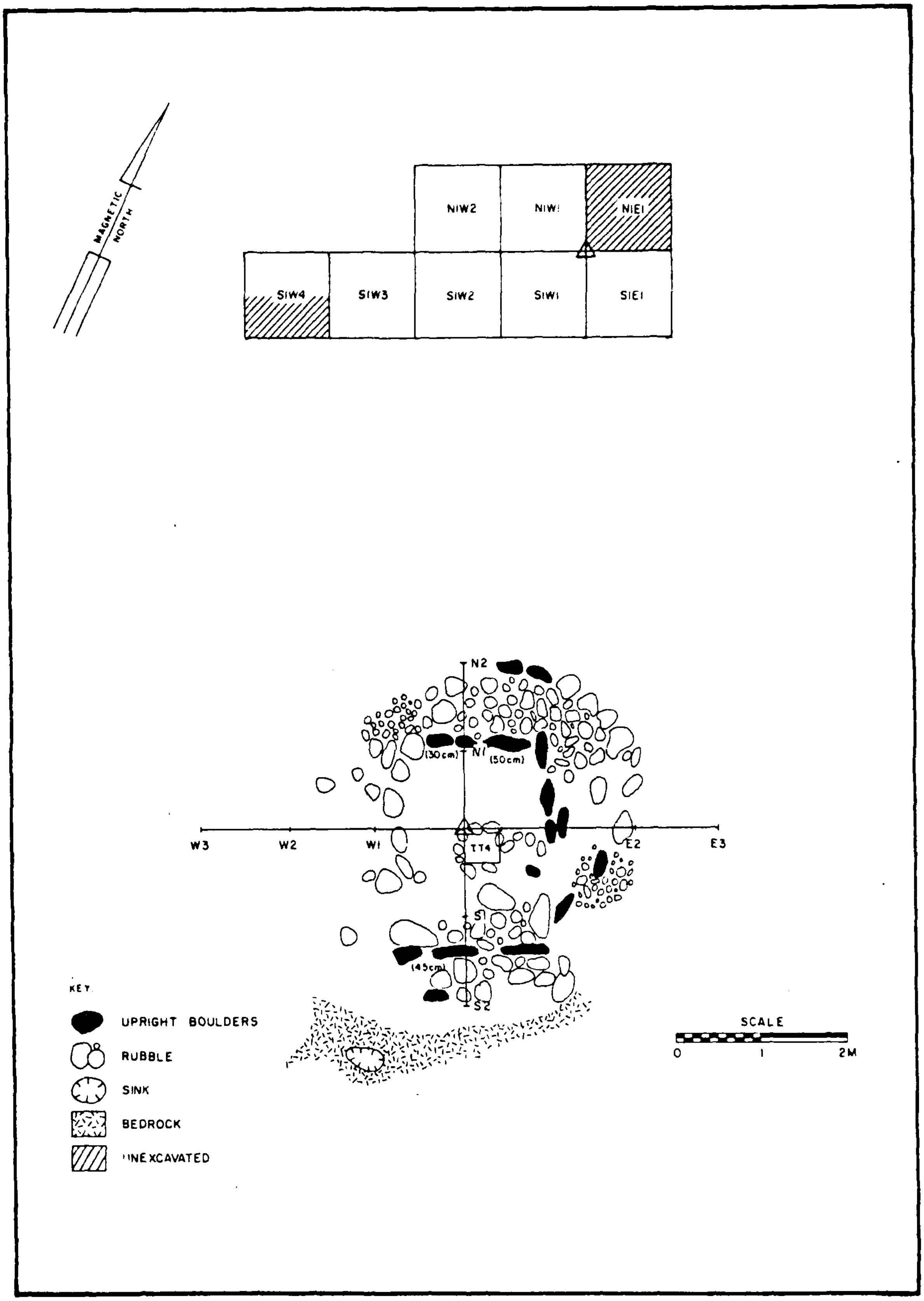


FIGURE 64 PLAN VIEW OF SITE 50-80-12-2789, SHOWING EXCAVATION GRID.

Excavation Results

Excavation conducted in the interior area of Site 2789, began with the expansion of the test trench, enlarging the 40 by 40-centimeter trench into a 1-meter square designated S1E1. The excavation trenches were then extended to the west wall and entranceway and then outside the enclosure. A total of 6 square meters was excavated.

The three (3) stratified layers present in the excavations are described here, from surface to lowest:

UNIT I — O and A1 horizon (10YR 2/1, moist); The matrix is fine silt loam, loose with weak discontinuous cementation. The A1 horizon ranges from 3 to 8 centimeters thick. The boundary is clear and wavy. The occasional shellfish remains present consist mainly of *Nerita picea*.

UNIT II — From 10YR 3/1 in the hearth to 10YR 4/1 in the site; A3 horizon. The matrix is fine, gravelly, silt loam, compact with weak, discontinuous cementation. Roots are common. Thickness ranges from 8 to 26 centimeters. The boundary is clear and wavy to gradual and irregular. This unit contains cultural midden and artifacts. It has a common interface with Stratum IV in the site's interior and interfaces with Stratum III outside the entrance.

UNIT III — Fine silt loam; C horizon, 10YR 7/4). This discontinuous unit is culturally sterile.

UNIT IV — Reef limestone bedrock.

Distribution of cultural material is shown in Figures 65 through 68.

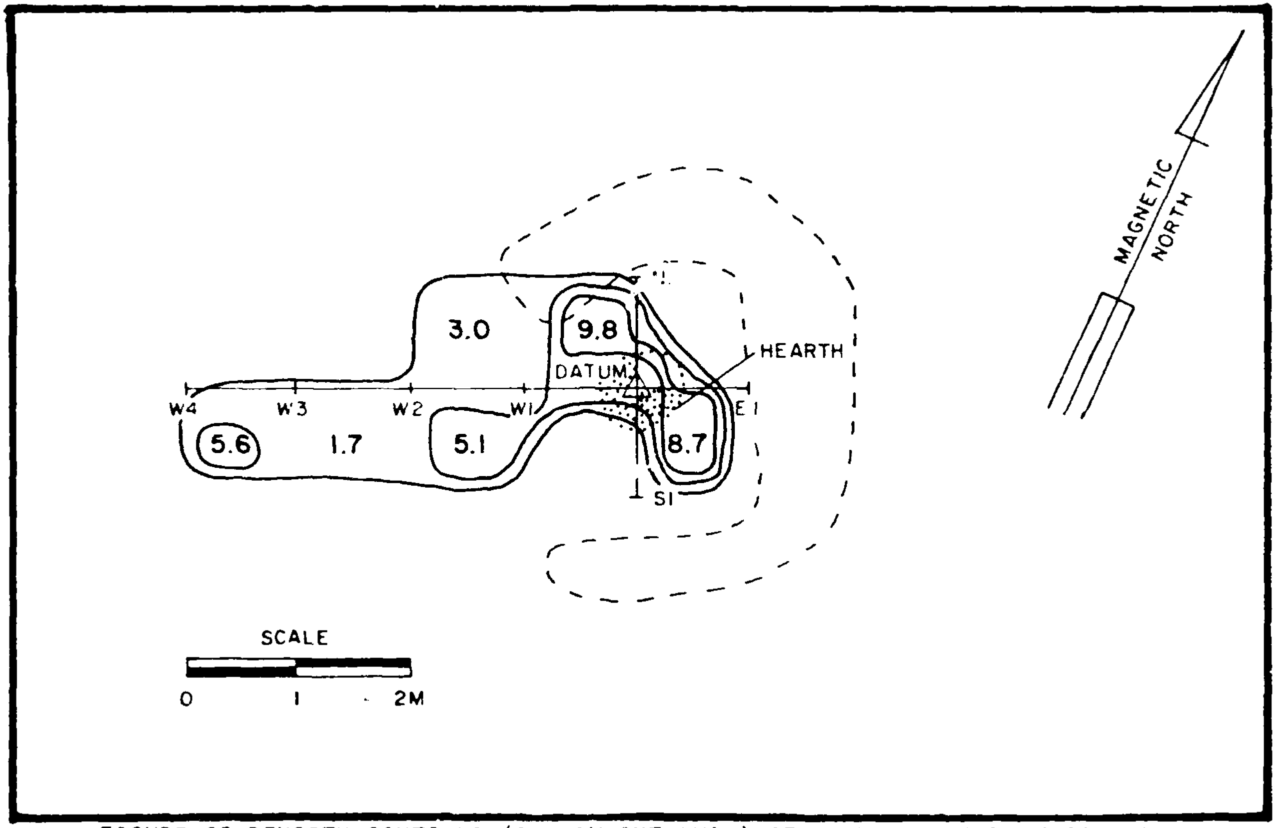


FIGURE 65 DENSITY CONTOURS (3 GRAM INTERVAL) OF MIDDEN WEIGHT, STRATUM I, SITE 50-80-12- 2789.

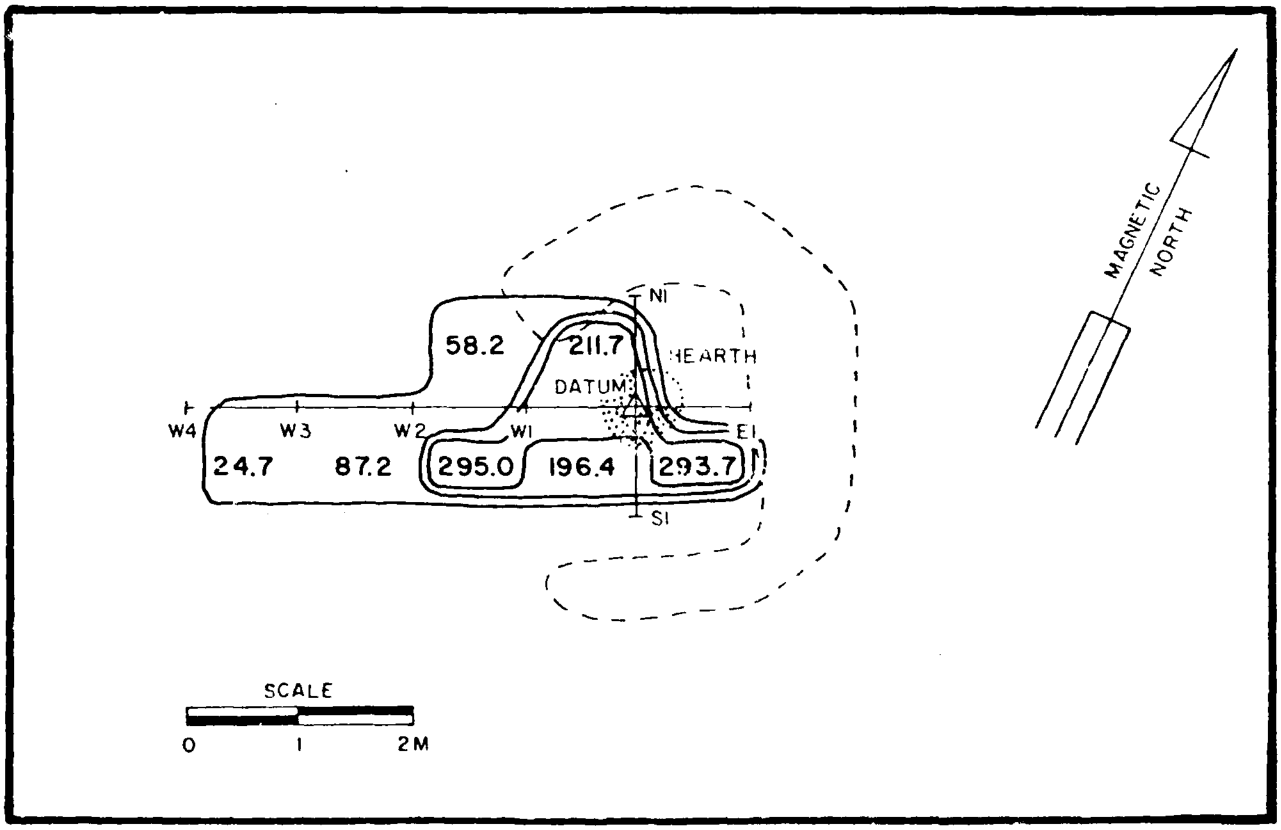


FIGURE 66 DENSITY CONTOURS (100 GRAM INTERVAL) OF MIDDEN WEIGHT, STRATUM II, SITE 50-80-12- 2789.

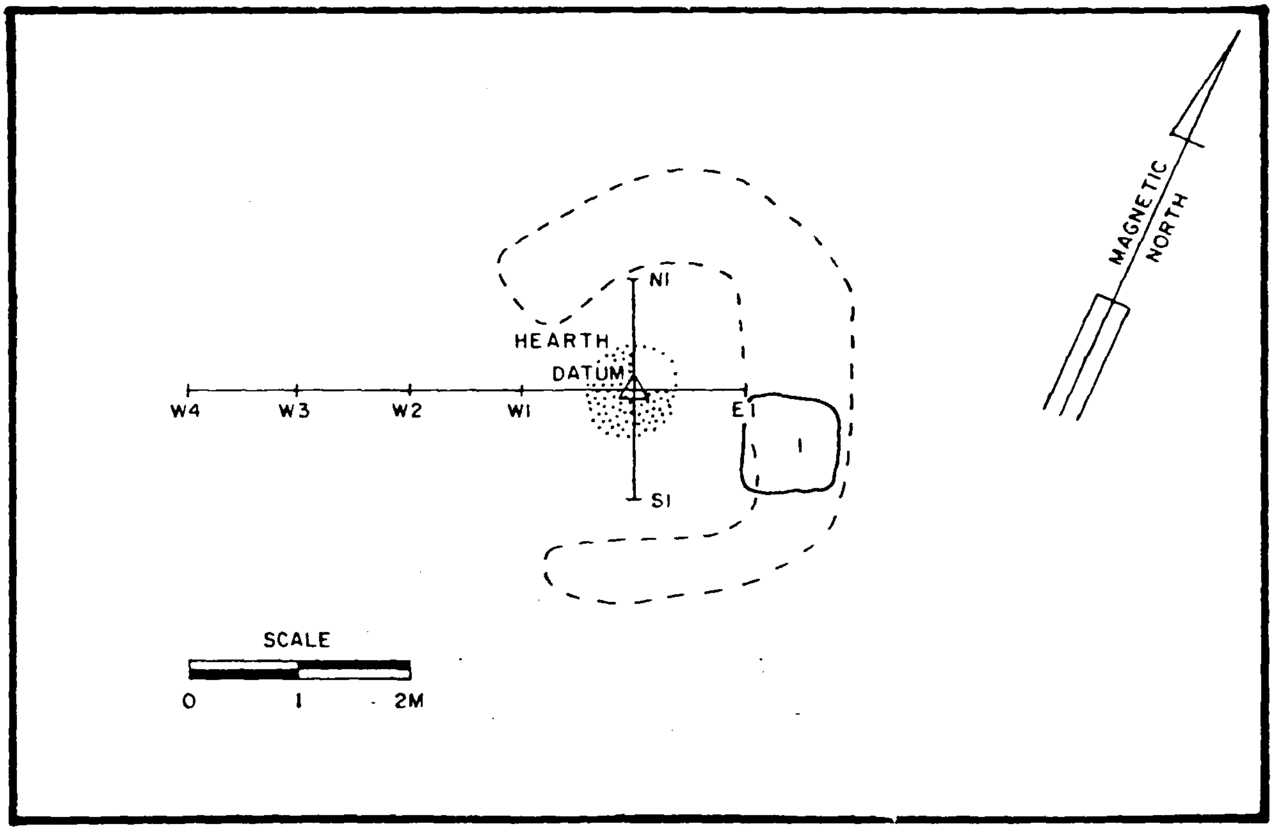


FIGURE 67 DENSITY CONTOURS (INTERVAL-1) OF ARTIFACTS BY FREQUENCY,STRATUM I,
SITE 50-80-12- 2789.

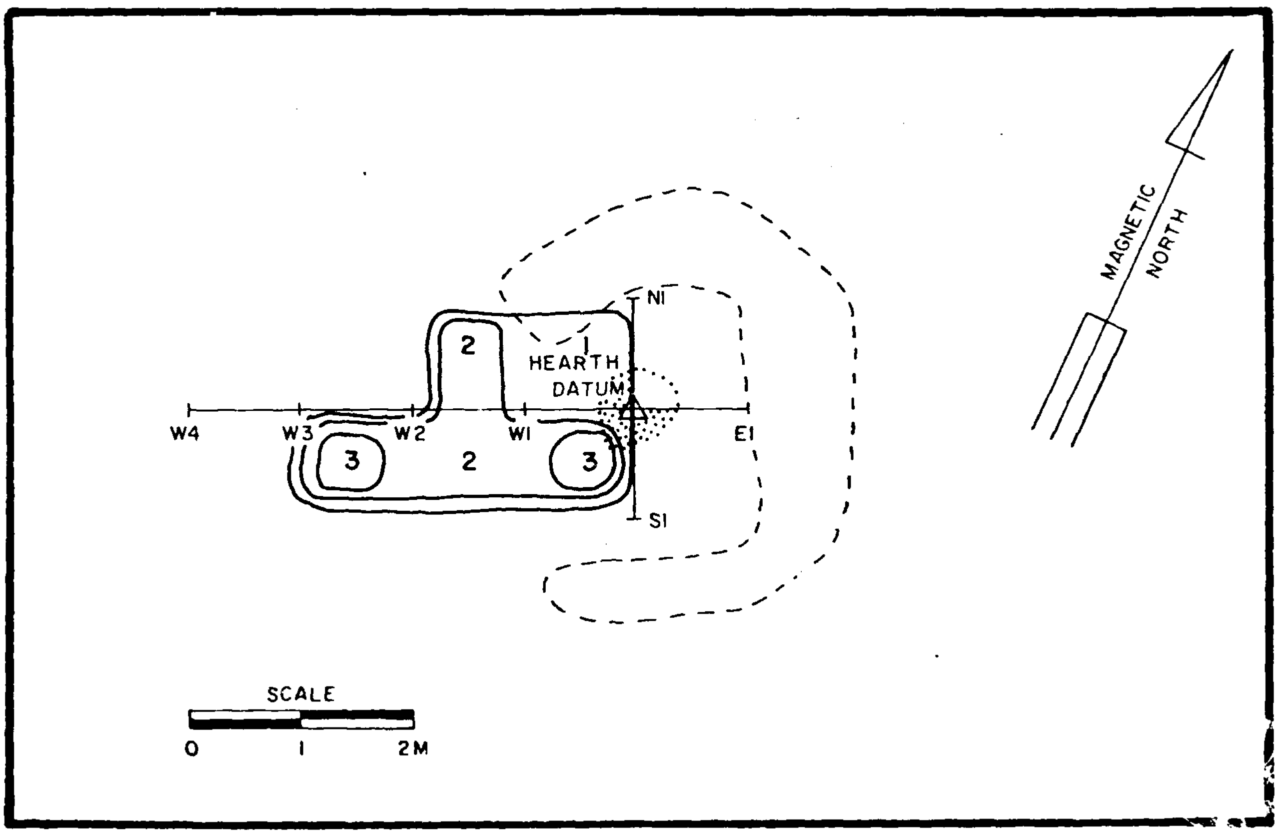


FIGURE 68 DENSITY CONTOURS (INTERVAL-1) OF ARTIFACTS BY FREQUENCY, STRATUM II,
SITE 50-80-12- 2789.

Midden quantity is very sparse in Stratum I and consists mainly of Nerita picea, Brachidontes, and Heterocentrotus mammilatus and probably is a result of mixing with the underlying unit. Midden in Stratum II consists of large quantities of shell remains, and fish and bird bones. Of the shell remains, Nerita picea and Brachidontes are the most prevalent, with Heterocentrotus mammilatus, Tellina rugosa, Pinctada radiata, Cypraea sp. and Drupa sp. present throughout the midden, but less numerous. This material is concentrated in and to the west of the hearth where ashy grey soil (10YR 4/1) predominates and where most of the Nerita and Brachidontes were collected. Midden quantity decreases sharply at the Stratum II/III interface and is present only in the uppermost few centimeters of Unit III.

The highest concentration of midden and artifacts are derived from the enclosure's entrance area, extending from the hearth area to the west. Artifacts recovered consist of four (4) coral files (including fragments), two (2) pieces of cut bone, two (2) basalt flakes, one (1) basalt cobble, one (1) shell scraper, and a single piece of basaltic glass.

The excavated trenches reveal that Stratum II extends 2 to 3 meters west of the structure. Initial occupation and site construction appear to be contemporaneous events and there are no discernible breaks in the occupation layer which could indicate multiple occupation phases. Thus Site 2789 is interpreted as a permanent habitation site, occupied for a undetermined period of time.

Site 50-80-12-2790

Description

Site 2790 (Figures 69 and 70) is a large, nearly circular (3.5 meters in diameter) solution sink hole with an oval-shaped opening, 2 meters east to west by 3 meters north to south. Depth to sink sediments from the ground surface ranges from 0.8 meters at the north to 1.2 meters at the south. Entrance to the sink is on the north side

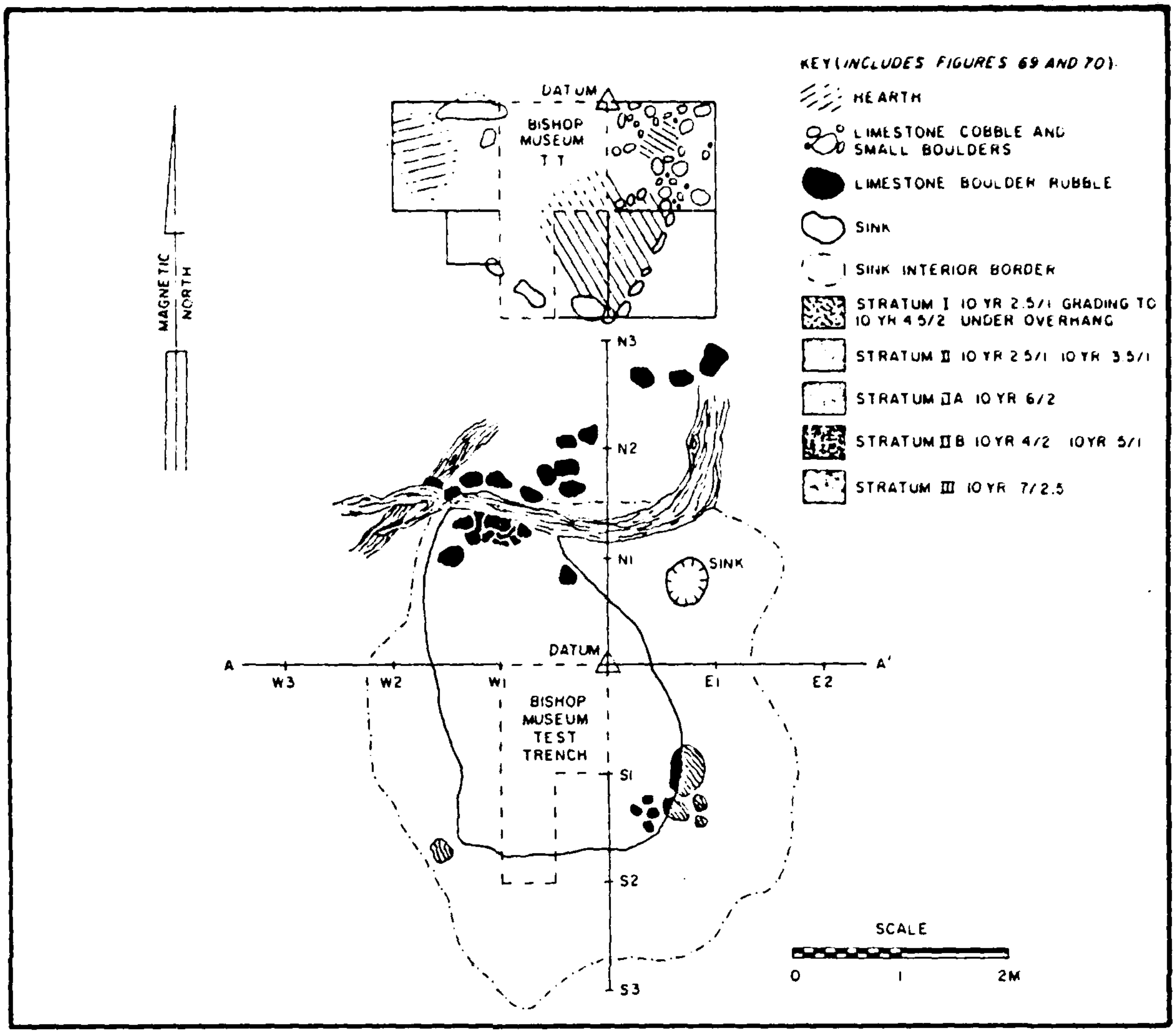


FIGURE 69 PLAN VIEW OF SITE 50-80-12-2790, SHOWING EXCAVATION GRID.

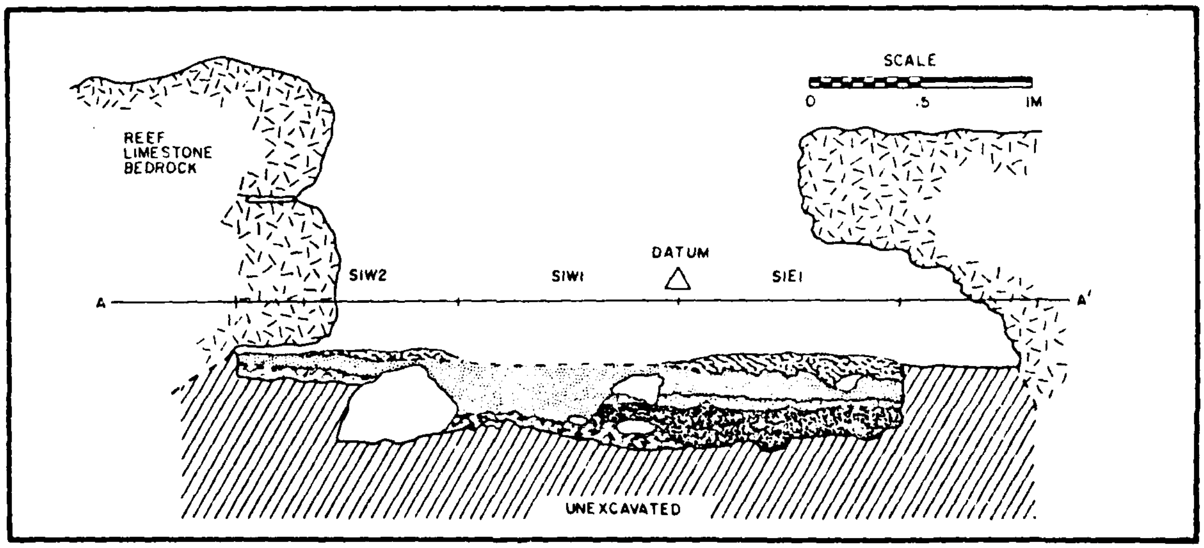


FIGURE 70 CROSS SECTION A-A' OF SITE 50-80-12-2790.

where faulting of bedrock has created "steps" allowing for easy access. The sink's sediment surface is strewn with limestone boulder and cobble rubble and is littered with modern organic debris. A few shell fragments visible on the surface of the sink's sediments are probably derived from the excavation of a test trench in 1976 (Sinoto).

Excavation Results

Salvage of Site 2790 consisted of the excavation of 3.75 square meters of the sink sediments. A previously excavated Bishop Museum trench (Sinoto 1976) in the center of the sink revealed the presence of a hearth and cultural refuse associated with a stratified layer. Trenches S1E1, S2E1 and S2W1 excavated during this study adjoin the Bishop Museum trench to the east. Trenches S1W2 and S2W2 adjoin the Bishop Musuem trench to the west. During excavation of Sink 2790, six (6) stratigraphic units were revealed and are described below, from the uppermost to the lowest unit (refer to Figure 70).

UNIT I — Recent O and A1 horizons. Fine, loose to loosely compacted, gravelly to very gravelly (under overhangs) silt loam, with colors of 10YR 2.5/1 in the center of the sink and 10YR 4.5/2 (under overhangs), Thickness ranges from 2 to 12 centimeters. Visible surface midden is probably derived from the previously excavated Bishop Museum trench.

UNIT II — Prehistoric (?) A3 horizion with a matrix of fine, loosely compacted, very weakly cemented very gravelly silt loam, 10YR 3.5/1. Thickness ranges from 6 to 28 centimeters. Two hearths were associated with this unit: one in S2E1 and S2W1, and the other in S1W2. The hearths deposits (10YR 2/1 to 10YR 3/1) contained a high percentage of charcoal. This unit contained fairly large quantities of cultural midden consisting mainly of shellfish remains with lesser quantities of mammal, bird, and fish bone. The artifacts contained within this unit were mainly detritus tool manufacturing, with the exception of one (1) completed fishhook.

UNIT II. : Fine to very fine, loosely compacted, very weakly cemented, gravelly sandy loam, 10YR 6/2; discontinuous C horizon. ranging in thicknes from 2 to 6 centimeters. This unit was found only within Trench S1E1, but probably was continuous throughout sink stratigraphy. However, because of the intrusive nature of Unit II, it is limited to the east portion of the sink. No cultural materials were found within this unit.

UNIT IIB Discontinuous buried A horizon, (10YR 4/2 10YR 5/1), fine, loosely compacted, very weakly cemented, gravelly to very gravelly silt loam with mottles of charcoal (10YR 2/1), Thickness ranges from 5 to 25 centimeters. This unit was found only within Trench S1E1 but probably covered more area within the sink. However, because of the intrusive nature of Unit II, it is limited to the east portion of the sink. Contained within this unit is a hearth-like feature comprised of an oval limestone cobble alignment with a high percentage of charcoal fragments but no concentrations of charcoal or ash and very slight charcoal-staining. A low percentage of portable artifacts and midden was present within this unit, with slightly higher quantity of bird bone midden than the upper units.

UNIT III C horizon (10YR 7/2.5) with a matrix of fine gravelly, cobbly, loamy sand. This unit was not completely excavated as it is culturally sterile. In portions that were excavated, the thickness ranged from 1 to 20 centimeters.

UNIT IV Reef limestone bedrock. The predominant fossil shell is a small Cypraea spp.

Midden and artifact distribution in Stratum I and II is shown in Figures 71 through 74. Midden in Stratum IIB is not shown because of the restricted (to the northeast quadrant of S1E1), discontinuous nature of the unit.

At least two (2) and probably three (3) phases of use of Sink 2790 are evidenced by the excavations. The earliest use relates to Unit IIB with its singular hearth-like feature which contained bird bone (identified as Pterodroma phaeopygia by Dr. Storrs Olson) midden and charcoal exclusively. The nature of Unit IIB occupation is unclear because of the sparse cultural remains and the disturbance caused by occupation associated with the overlying Unit II.

Unit II represents a later and much more intensive occupation than Unit IIB, as indicated by the presence of two (2) hearths and significantly greater quantities of midden and artifacts and a thickness of up to 30 centimeters for the deposit. A large central hearth in S2E1 and S2W1 (refer to Figure 69) is situated in the lower half of Stratum II and is covered by 10 centimeters of Stratum II material. Another hearth, in S1W2, visible on the surface of Unit II is associated with the upper levels of Stratum II. This shift from the large centrally located hearth in the lower levels of Stratum II to the small hearth located adjacent to the west side of the sink and in the upper levels of Stratum II indicates a change in the function of the site. This could be due to a shift in occupation sites from the sink (2790) to the adjacent surface Site 2787 by the inhabitants but with continued use of 2790 for other purposes.

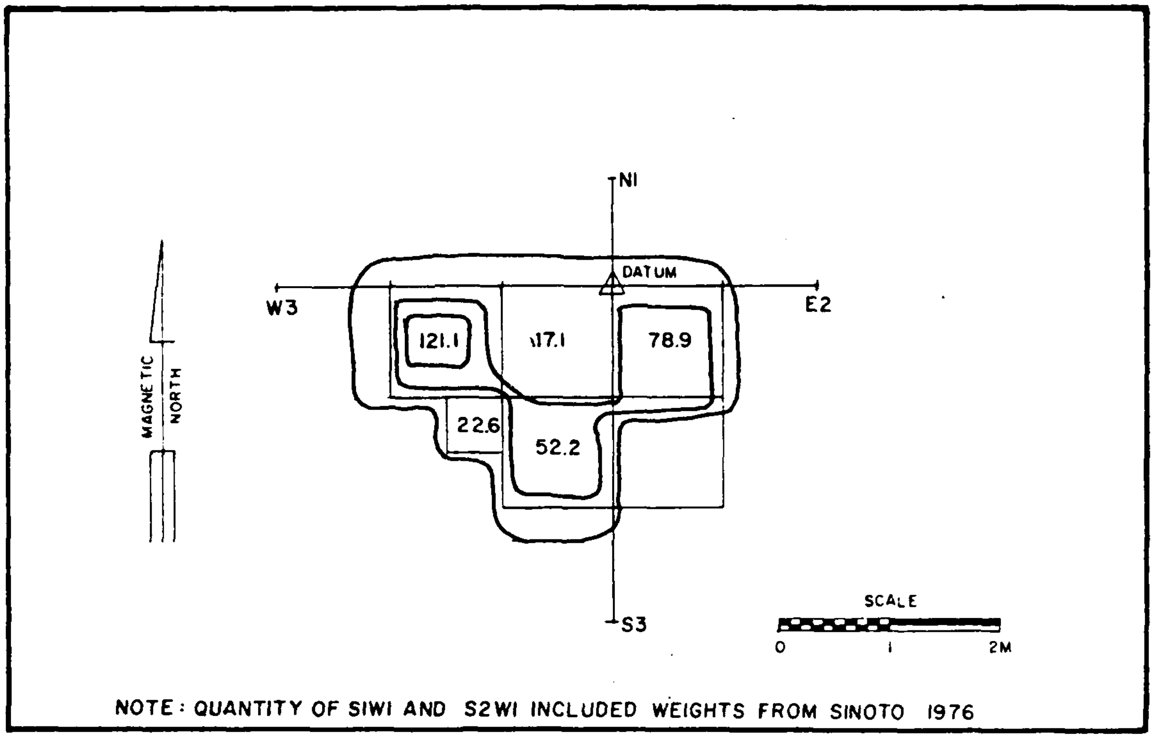


FIGURE 71
DENSITY CONTOURS(50 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM I
SITE 50-80-12- 2790.

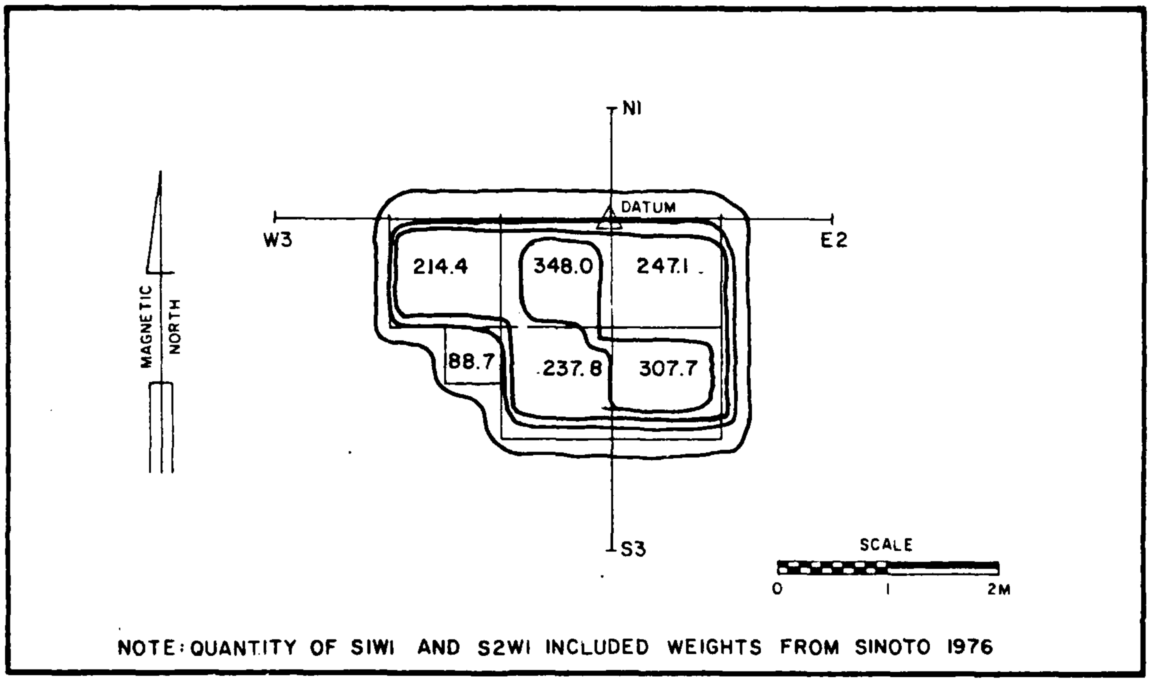


FIGURE 72
DENSITY CONTOURS(100 GRAM INTERVALS) OF MIDDEN WEIGHT, STRATUM II
SITE 50-80-12- 2790.

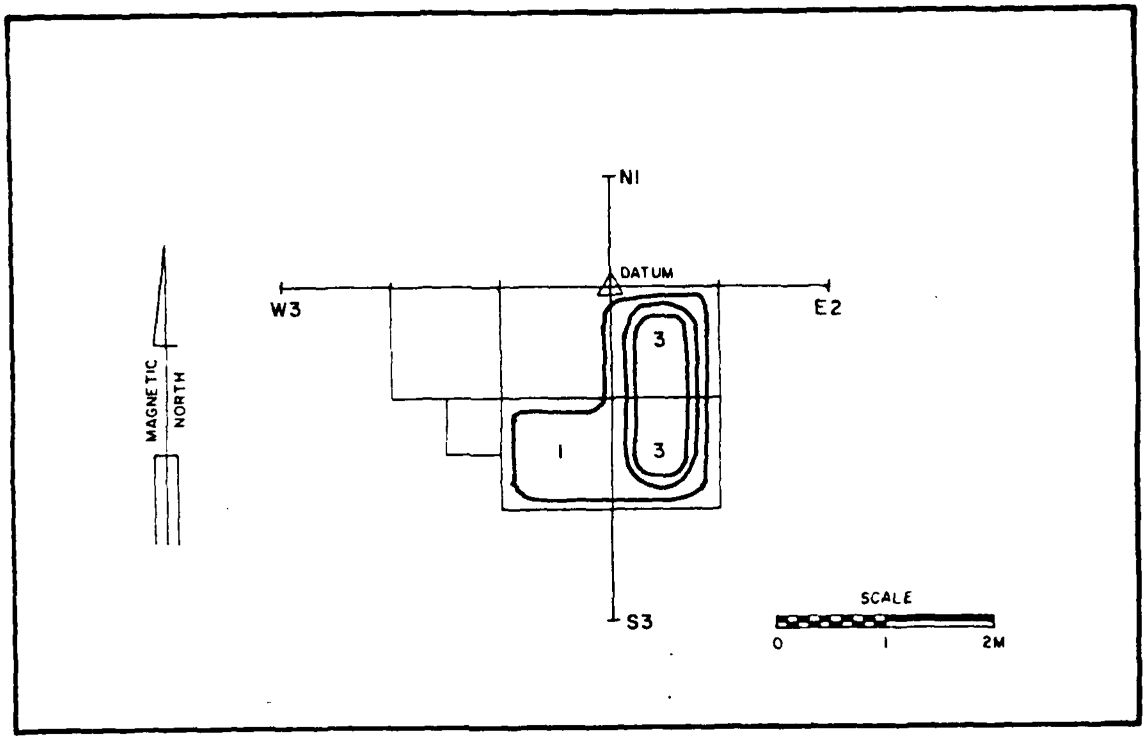


FIGURE 73
DENSITY CONTOURS(INTERVAL - 1) OF ARTIFACTS BY FREQUENCY, STRATUM I
SITE 50-80-12-2790.

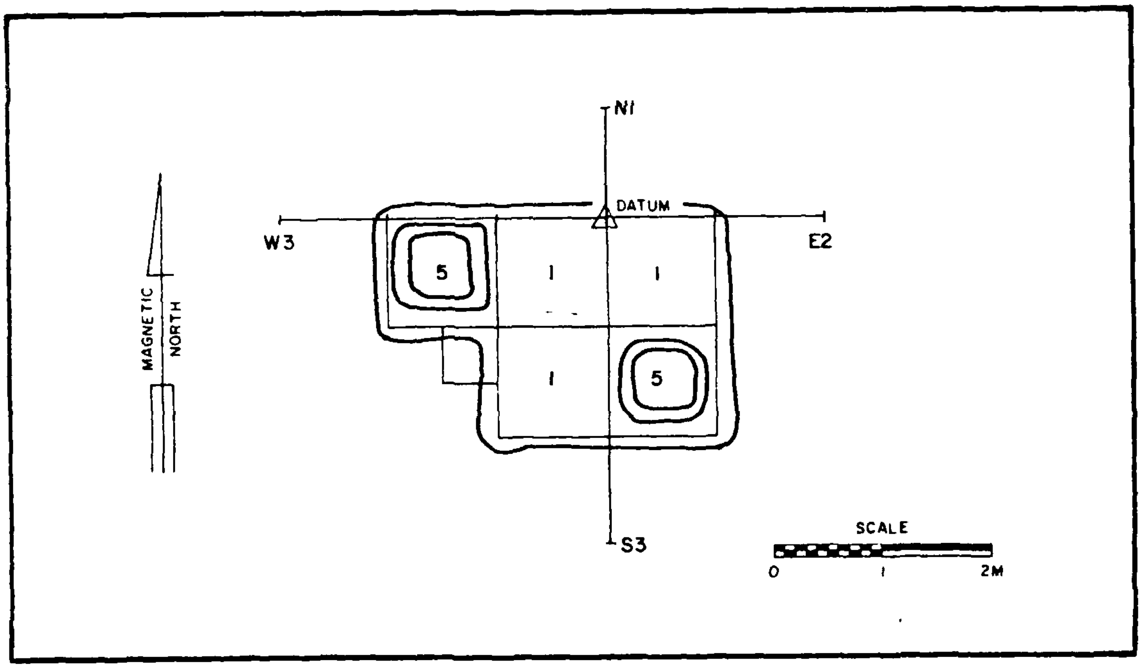


FIGURE 74
DENSITY CONTOURS(INTERVAL - 2) OF ARTIFACTS BY FREQUENCY, STRATUM II
SITE 50-80-12-2790.

Site 50-80-12-2791

The salvage of Site 2791, a narrow gauge railroad berm, consisted of additional survey work (summarized below) and historical research (Appendix III). This berm has been disturbed heavily by logging and bulldozing. It is situated in Optional Area 1 and extends some 172 meters (564 feet) from near Site 2789 in a northeasterly direction ranging from 34° to 37° True. The berm is 1.22 meters (48 inches) wide, ranges in height from 5 to 50 centimeters, and is built of limestone slabs, cobbles, and pebbles. A few rail sections and cross ties are still present on and adjacent to the berm in the vicinity of Site 2789. Some of the cross ties are hand-hewn logs while others are saw-cut, milled boards. The distance between the two closest in situ cross ties is 91 centimeters (36 inches). A few of the cross ties have rail spikes in place and the distance between the spikes (i.e., the tracks) ranged from 59 to 61 centimeters (23 to 24 inches).

Three (3) historic metal artifacts were collected from this berm. Two are railroad spikes and the third is possibly a bell clapper. No actual excavation was done on the berm.

Site 50-80-12-2797

Description

Site 2797 (Figure 75) is an oval-shaped sink complex comprised of two (2) adjoining sinks. The southern sink is 1 by 1.5 meters and is approximately 1.5 meters in depth. When the "roof" collapsed a large pile of rubble was left as the "floor" surface. The northern sink is 1 meter in diameter and 1 meter in depth, with a partially collapsed "roof", and is capped by a limestone slab ahu. The ahu is 1.5 meters in diameter and 0.5 meters in height, and is constructed with a small, vertical opening (12 centimeters in diameter) through the center of the ahu.

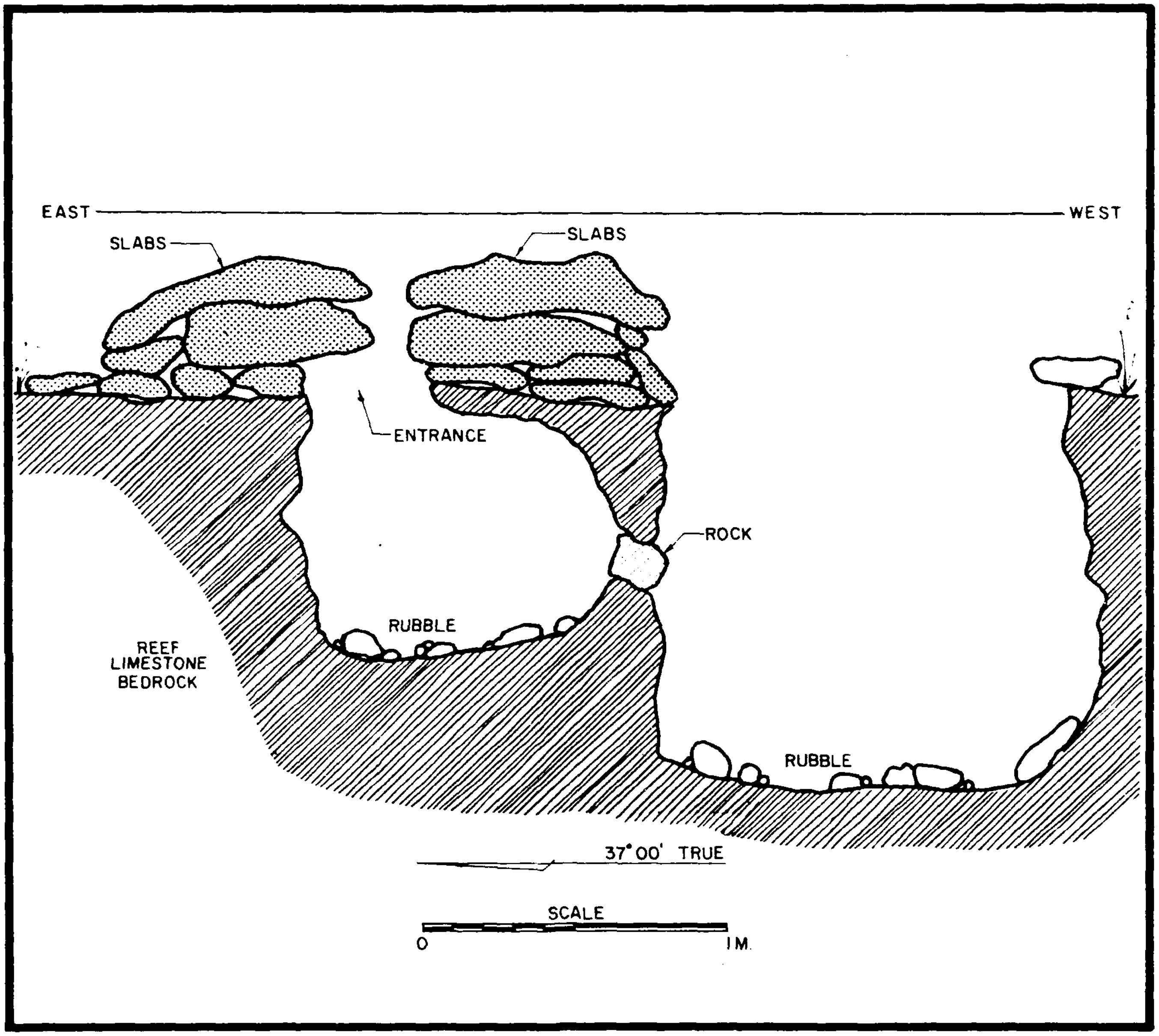


FIGURE 75
EAST-WEST CROSS SECTION OF SITE 50-80-12- 2797.

Excavation Results

Salvage of Site 2797 consisted of dismantling the ahu and inspecting the rubble on the sink floors. No cultural materials were found in the ahu or within the sinks. The function of this site is unknown, but it is probably of recent age and could have supported a flag or signal pole associated with the railroad.

Site 50-80-12-2604

Description

Site 2604 (Figure 76) is a rectangular-shaped enclosure, with an opening facing the southwest. The enclosure measures 3 by 4.5 meters, with stacked limestone slab walls ranging in height from 0.5 to 1 meter. The interior of the enclosure contains a red colluvial deposit with raised waterlines (from floods) visible upon the rocks of the walls. The enclosure was in a good state of preservation, with sharp right angled corners and vertical facings to the walls.

Excavation Results

Salvage of Site 2604 consisted of dismantling portions of the north and south walls to determine the construction design and relationship of the structure to underlying strata. The structure was found to be built directly upon reef limestone bedrock with no cultural layer present. Two (2) strata were present within the interior of the structure and in depressions in the bedrock, under the walls. These strata are as follows:

UNIT I — Dark reddish brown (5YR 3/4 moist) silt loam. This unit is a culturally sterile colluvial deposit averaging 3 centimeters thick.

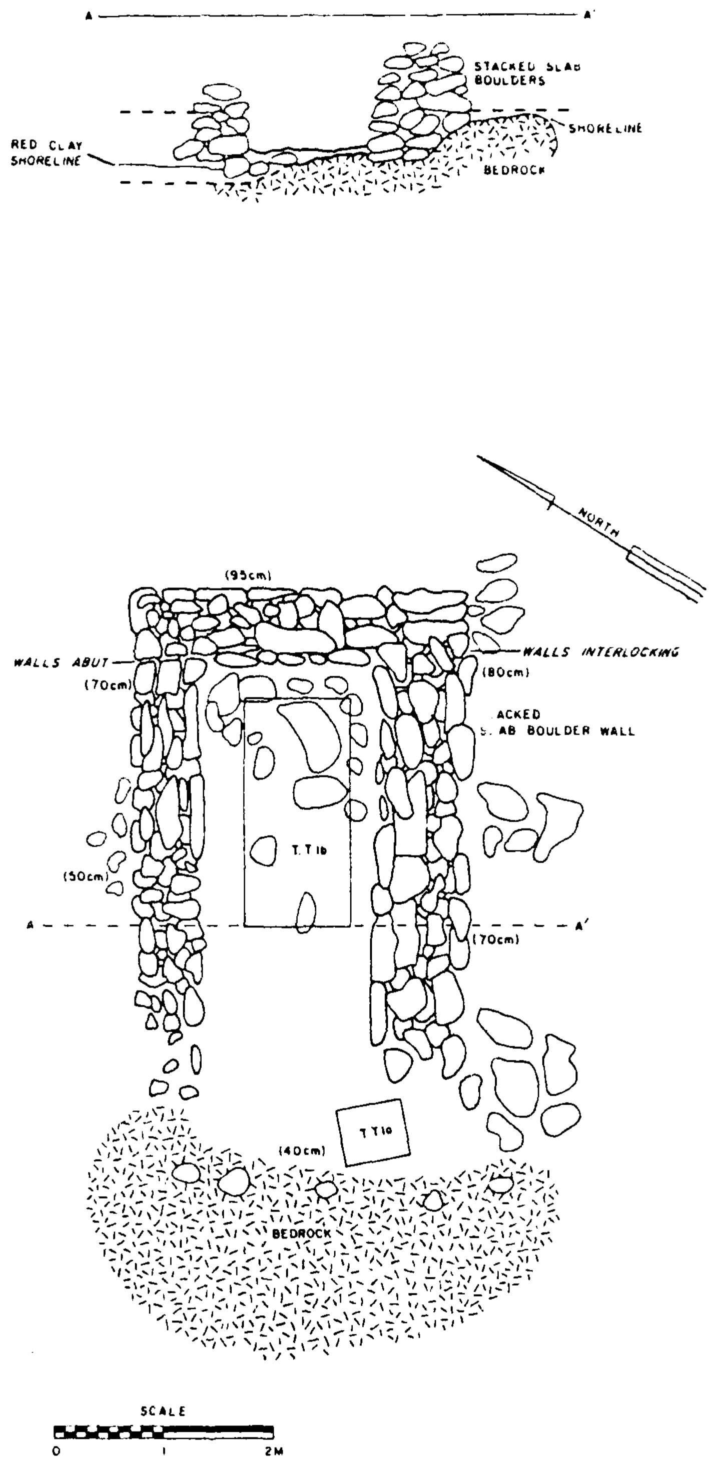


FIGURE 76 PLAN VIEW AND CROSS SECTION OF SITE 50-80-12-2604.

UNIT II Brown (7.5YR 4/4 moist) gravelly silt loam to sandy loam. This unit is a culturally sterile C horizon.

Based on the absence of cultural materials, midden and portable artifacts, and the modern deposits within and around the enclosure, a recent historical age is indicated for this site.

Site 50-80-12-2609

Description

Site 2609 is a roughly oval, 2.5 by 3.5 meter, bell-shaped solution sink with a depth of 2 meters (not illustrated). A natural arch divides the sink opening into two (2) separate portions. The floor of the sink is relatively level soil, with a small 1.0 by 1.5 meter, crescent-shaped pile of limestone cobbles and boulders abutting the sink's north wall. This sink is situated at the map location given by Davis (1978). In his report, Davis described the sink as having a possible burial function with human bones present on the floor surface. During salvage work no bones were seen on the surface.

Excavation Results

Excavations at Site 2609 consisted of two (2) 25-centimeter square trenches, one at the west end of the sink and the other at the east end, both abutting the wall of the sink. The stratigraphic units present are described below, from topmost to lowest.

UNIT I A horizon 5YR 3/4, dark, reddish brown colluvium, with an average thickness of 15 centimeters. No cultural material was present.

UNIT II C horizon, 7YR 4/4, with an average thickness of 30 to 40 centimeters. No cultural material was present.

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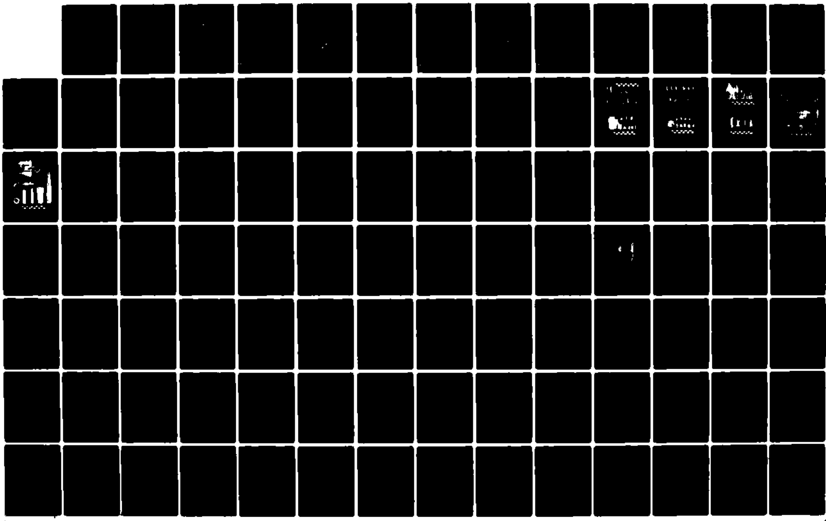
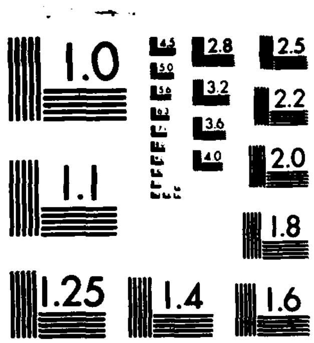




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Excavations were originally initiated for paleontological research, but because of low quantities of avifaunal remains and since no cultural materials were found, no further excavations were undertaken. No human skeletal remains were found in the sink nor in the excavated trenches.

Site 50-80-12-2617

Description

Site 2617 (Figure 77) consists of two (2) surface features, with three (3) sinks in the vicinity. Feature A is a roughly oval-shaped feature, 2.5 by 4.5 meters, with level soil interior and low, irregular boundaries. This structure was probably produced by bulldozing and logging activity, since a 50-centimeter square test trench revealed only a recent O horizon on bedrock. Feature B is a roughly rectangular terrace, 1.5 by 2.0 meters in size, with a level soil interior and is bounded on the east and north sides by a single limestone boulder alignment, 10 to 40 centimeters high. A large limestone bedrock slab forms the west side and the terrace steps down towards the south. Of the three (3) sinks, two (2) average 1 to 1.5 meters in diameter, and 1.25 meters to 1.5 meters in depth and all are filled with limestone rubble. The third sink is 1 meter in diameter and 3.25 meters in depth, with a limestone rubble floor. Because of the rubble floors and since no modifications were made to the sinks, no utilization or function was indicated. Extensive recent disturbance is evident adjacent to the cultural deposit.

Excavation Results

Excavation of Site 2617 was initiated with two (2) 50-centimeter square test trenches, one within Feature A and the other within Feature B. Feature A test trench, as noted earlier, revealed a recent 0 horizon on bedrock and the excavation was discontinued. Feature B

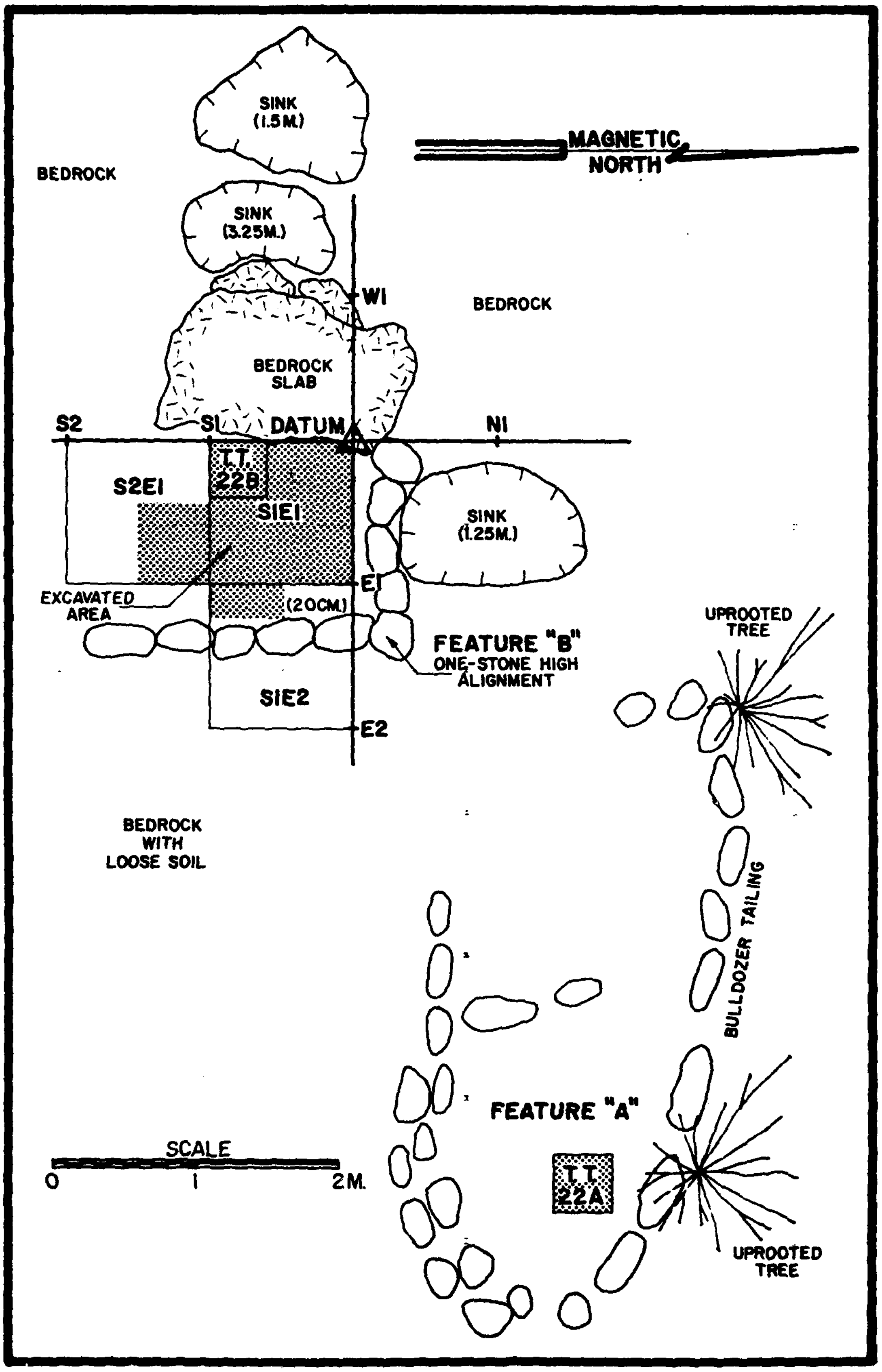


FIGURE 77
PLAN VIEW OF SITE 50-80-12-2617, SHOWING EXCAVATION TRENCHES

test trench revealed four stratigraphic units and therefore was expanded from a 50-centimeter square trench to a 1 by 1.5-meter trench. The units present in the excavation are described below, from the topmost to the lowest.

UNIT I — 0 and A1 horizons. The matrix is fine, gravelly silt loam. Thickness ranges from 3 to 7 centimeters. This unit contains a high percentage of organic material, mainly kiawe sawdust and chips derived from recent kiawe tree-cutting activity. Very sparse shellfish remains (mostly Nerita) are present. The lower boundary is clear and wavy.

UNIT II — Prehistoric (?) A3 horizon with a matrix of fine slightly compacted, gravelly silt loam (10YR 4/1). The average thickness of the unit is from 5 to 7 centimeters. This unit contains a low percentage of shellfish remains, charcoal, and rodent bones, with no artifacts present. The lower boundary is wavy and clear.

UNIT III — C horizon; fine, gravelly silt loam, 3 or more centimeters thick. This unit fills the interstices of cracks in the bedrock and is culturally sterile.

UNIT IV — Reef limestone or sandstone bedrock.

Because of the low density of midden, the absence of portable and nonportable artifacts and the extensive recent disturbance, excavations at this site were terminated. This site might have functioned as a temporary occupation feature occupied only once for a brief period or it may be a remnant of a larger site which has been all but obliterated.

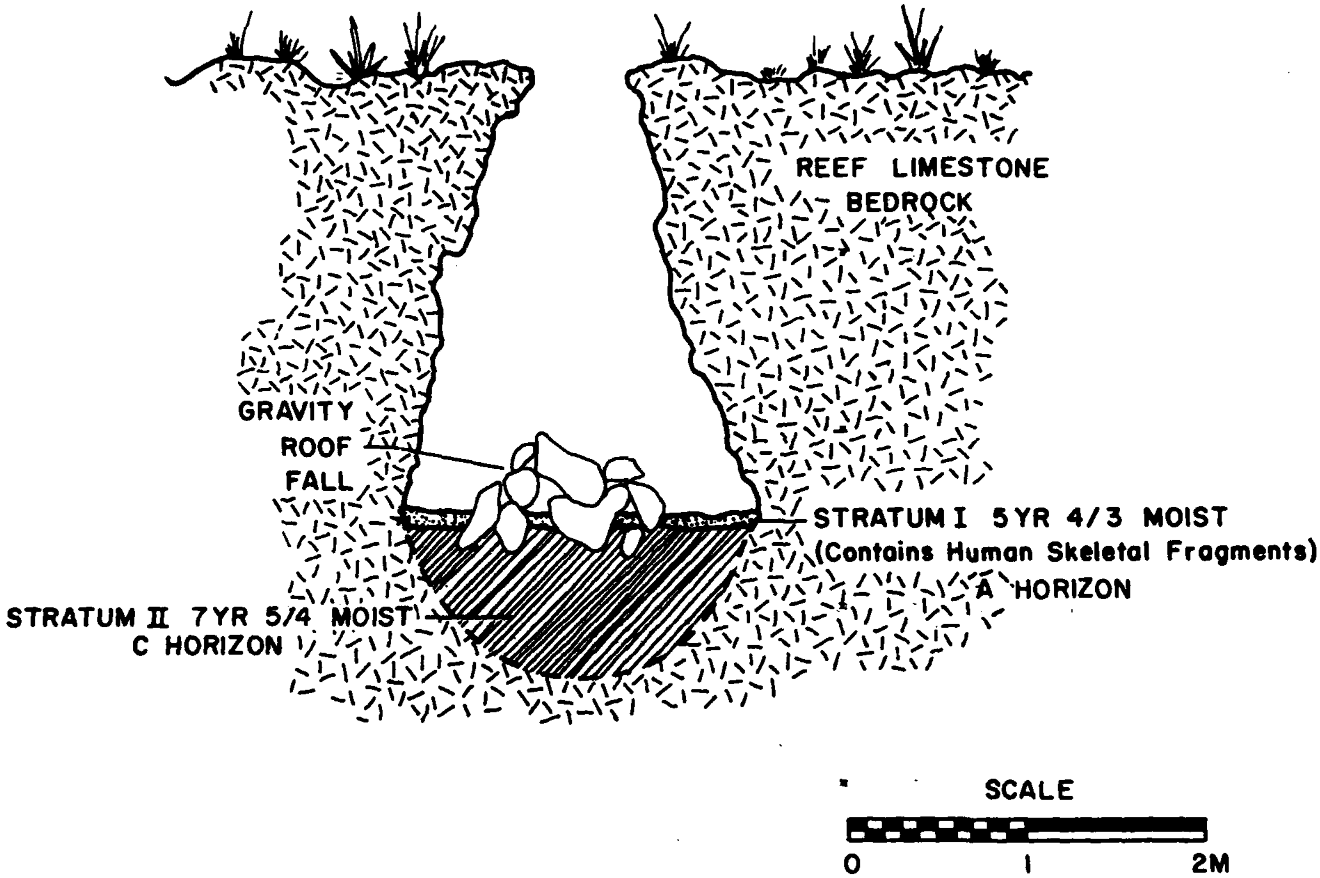


FIGURE 78 SCHEMATIC CROSS SECTION OF SITE 50-80-12-2620.

Site 50-80-12-2620

Description

Site 2620 (Figure 78) is a roughly circular (2.5 to 3 meters in diameter) solution sink, 3 to 3.5 meters deep, with a small, circular opening 0.75 meters in diameter. The floor of the sink is made up of large slabs of limestone with boulders and cobbles in an irregular pile. This colluvial material is encrusted with dark reddish-brown silt loam, indicating a recent increase in silting in the general area due to sugarcane-growing operations.

Since the surface survey report (Davis 1978) listed this site as a burial sink with human bones scattered on the floor surface, salvage excavations were undertaken.

Excavation Results

Excavation of Site 2620 was initiated with a 50-centimeter square trench abutting the sink wall in the northwest portion of the sink floor. A trench was excavated here because human skeletal material (a humerus) was protruding from the surface colluvium. Continuation of the excavation yielded human skull fragments and a few bird bones. The human bones were exclusively within this uppermost unit, indicating recent deposition, probably due to flooding of the sink. Further excavations along the floor's perimeter failed to yield any more human bones. Then the boulder colluvium was excavated down to the C horizon but no cultural material was discovered.

Two stratigraphic units are present in the excavations. These are described next, from topmost to lowest.

UNIT I — A horizon (5YR 4/3, moist); dark reddish-brown, silt loam. Thickness averages from 5 to 7 centimeters. Human bones and avifaunal remains were found on the surface and in this A horizon. No other cultural material, shellfish remains, charcoal, or artifacts were present.

UNIT II C horizon (7YR 5/4, moist), very gravelly silt. This unit was culturally sterile, with some rodent and bird bones present.

The human skeletal material from this sink was turned over to Campbell Estate and their consultants. Hence no laboratory analysis was conducted by Archaeological Research Center Hawaii, Inc. However, based on field observations, disarticulated and fragmented remains of several individuals were present.

Site 50-80-12-2621

Description

Site 2621 (Figure 79) is a bell-shaped solution sink with two (2) distinct, interior levels. The entrance to the sink measures 0.4 by 0.7 meters by 1.2 meters deep to the first or uppermost level. The first level is roughly oval-shaped and measures 1.3 meters north to south by 2.7 meters east to west. The second or lowest level is separated from the first level by five (5) limestone slabs which act as capstones for the second level. The second level contains disarticulated human skeletal remains and is roughly oval shaped and measures 2.2 meters north to south by 2.5 meters east to west. Its depth from the surface is 2.1 meters.

Excavation Results

Capstones were removed from the first level of Site 2621 and then the skeletal material was excavated from the second level. The skeletal material was primarily on the surface but was also present to a maximum depth of 30 centimeters. The bones were disarticulated and scattered

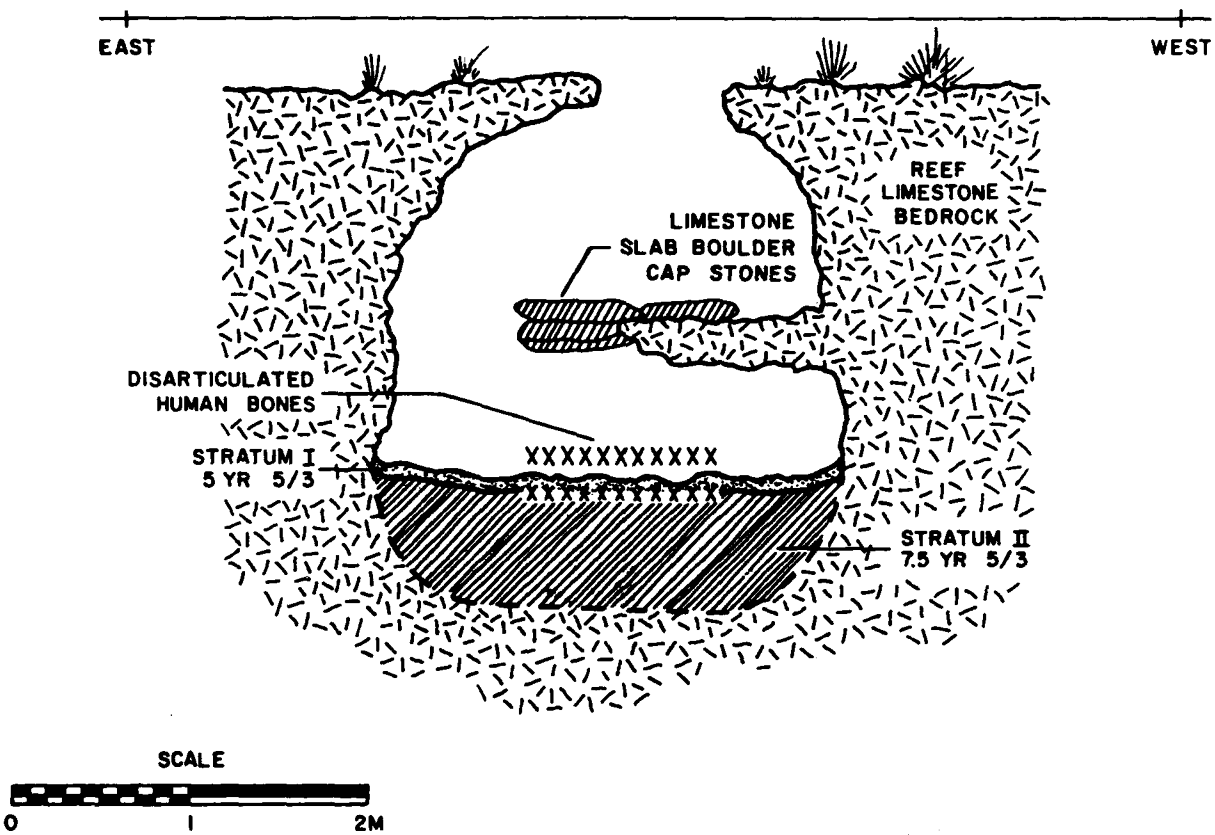


FIGURE 79 EAST-WEST CROSS SECTION OF SITE 50-80-12-2621

about the floor of the sink with a higher percentage of bones along the floor perimeter. A small percentage of bones was on ledges a few centimeters above the floor sediments and two (2) crania and some long bones were on a ledge approximately 45 centimeters above the sink floor.

The two (2) stratigraphic units present in the excavation are as follows, from the uppermost unit to the lowermost unit:

UNIT I: Gravelly silt loam (5YR 5/3) with a low percentage of dark reddish-brown alluvium and an average thickness of 8 centimeters. This unit contained the majority of human skeletal remains, with some small rodent and bird bones also present.

UNIT II: Gravelly silt loam (7.5YR 5/4), C horizon, with a low percentage of human skeletal material, and rodent and bird bones.

The human skeletal material form this sink was turned over to Campbell Estate and their consultant, so no laboratory analysis was conducted by Archaeological Research Center Hawaii, Inc. However, field observations showed that the sink contained multiple burials. The disarticulation of the skeletal material was due in part to flooding of the sink floor and burrowing of rodents. Older burials within the sink, however, were probably moved around to make room for successive interments. The moving of previous burials within the confines of this small sink could account for most of the disarticulation and the mixture of bones into Unit II.

No midden or portable artifacts, such as grave goods, were observed during excavation or screening. Sink 2621 functioned as a multiple burial chamber and was the only sink found with this function within the project area.

MIDDEN ANALYSIS

All excavated sediments were passed through a 1/4-inch and a 1/8-inch galvanized screen simultaneously. The sampling bias induced by the screen size (¼ inch) from which the midden sample (Table 3) was collected is considered an insignificant skewing factor in the sample. This is based on the results of tests quantifiying the various components of the Kalahuipua'a (Kirch 1979:120, Table 10) and Kahalu'u (Kirch 1973:24, Table 3) middens that passed through a ¼ inch mesh screen. Similar tests were not conducted for the Kalaeloa middens because the categories and taxa in the three assemblages are similar. All midden material retained in the ¼ inch screen was collected and bagged by provenience. All material retained by the 1/8-inch screen was discarded after collection of all artifacts including basaltic glass and all midden materials not present in the ¼ inch screen. The use of the ¼ inch mesh screen in conjunction with the 1/8 inch mesh facilitated the collection of fragmented and minute artifacts by eliminating 50 percent to 80 percent by volume of the excavated material from the 1/8 inch screen. The importance of basaltic glass as a datable material in Hawaiian archaeological sites has been documented in the last decade. Its importance in determining chronology at Kalaeloa is further intensified because of the scarcity and apparent contamination of charcoal from the sites in the present study areas. Therefore, the recovery of basaltic glass was emphasized during the fieldwork and all field personnel were specially orieted to search for basaltic glass.

Midden analysis consisted of sorting and weighing of the components by site, stratum, excavation unit and depth. Total weight per family, genus or species were calculated for each site. Concentration indices were not done because of the extreme difficulty in calculating the volume of excavated units due to the wavy and frequently convoluted strata boundaries, particularly when bedrock was encountered.

The intersite comparisons were made on the basis of gross weights rather than percents. Percent can be calculated from the

TABLE 3 MIDDEN COMPONENTS BY WEIGHT FROM EXCAVATED SITES

SITE	2712		2723		2730		2731		2732		2745		2763		3663		3622		2768		2777		2778	
STRATUM	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
GASTROPODA (UNIVALVES)																								
Cassis cornuta	33.7	7.3																						
Cellana exarata	55.5	.7			2.2																			
Cerithium hawaiensis	5.1	4.5																9.2						
Conus spp.	305.4	264.5	1.0	9.1	2.0	30.5	11.9	7.0	14.5		30.5	109.3	1.9	5.1			16.2	140.8				51.6		59.5
Cymatium muricinum								.9									2.0	5.9						
Cypraea spp.	167.0	774.6	49.9	29.9	29.5	82.1	1.6		7.7		22.8	59.2	3.8			6.1	5.2	45.3			1.1	32.6		14.5
Distorsio anus																		9.1						
Drupa ricina	13.5	37.1	39.2	22.1	6.2	20.0		.2	9.8		4.8	96.9		1.6			10.0	46.9				1.5		
Hipponix imbricatus	.3	1.7			1.1																	6.2	.2	.3
Hipponix pilosus	1.4	4.5			1.3	.7																		
Littorina spp.			28.4	45.6	.2	6.5	.2	.3			.8	1.1	.4	22.2		.1	1.7	4.7				2.8		.5
Mitra nodosa	5.0																							
Mitra stictica																								
Nerita picea	503.8	3084.9	550.0	1004.0	307.5	466.7	12.9	138.4	122.9		23.3	372.5	13.7	346.7	.2		402.7	3989.9			1.1	14.8		.9
Polinices tumidus																								
Purpura aperta	2.3	4.9																						
Rhinoclavis fasciata																		12.1						
Strombus maculatus																								
Terebridae		2.0		7.2				6.1																
Trochus intextus	10.2	15.6		.9			1.8	.2													7.9	.4		.7
Turbo sandwicensis	25.8	46.3		3.8	3.4	7.1		16.6			.2	.2		4.1			3.9	44.9			1.4	16.5	1.6	82.6
TOTAL	1124.0	4253.6	718.0	1124.5	352.4	612.9	28.4	169.7	154.9		82.4	639.6	19.8	380.6	.2	6.2	439.7	4304.8			11.5	120.8	1.8	144.5
PELECYPODA (BIVALVES)																								
Anomia nobilis	13.2	15.3												5.0										
Brachidontis crebristriatus	29.6	213.8	.4		32.9	287.2	.1				.2	1.5		1.4	1.4		20.2	163.2			.3	107.1		.4
Codakia punctata		1.5															10.9	26.6	.1	.1		56.4		4.7
Isognomon spp./Pinctada spp.	51.0	147.6	1.2	2.4	11.8	11.4	5.4	28.4			2.1	11.2	.2				1.2	6.9				3.9		.8
Periglypta reticulata	13.1	45.1		1.8		.2		3.4							12.4		18.0	84.3	5.3	5.3	1.8	169.8		1.6
Tellina palatum	58.9	257.3	4.0	6.7	14.7	68.7	13.3	47.0	2.2		.4	3.4	6.2	22.2										
Trachycardium orbita	3.7	1.5																						
Venus hawaiensis																								
TOTAL	163.5	682.1	5.6	10.9	59.4	368.0	18.8	78.8	2.2		2.7	16.1	6.4	28.6	13.8		50.3	383.0	5.4	5.3	2.1	337.2		7.5
ECHINOIDEA (URCHINS)																								
Echinometra mathaei	.1	13.4			.6			.5			.1	3.0	.2	1.4			.6	16.9			.1	7.6		.1
Echinothrix diadema	94.8	449.6	15.6	6.3	2.8	9.7	54.9	182.3	12.0		.2	9.0	2.9	9.9	1.3		19.3	276.6				20.7	.7	5.9
Heterocentrotus mammalatus						1.1						.5						7.8		.5	.3			
Podophora atrata	.7							.1																
Skeletal parts	5.3	46.4	.3	2.5	.3	1.5	2.2	41.7	1.6		1.4	10.3	1.8	1.6	9.5		4.1	75.2	1.7	.3	.6	6.2		
TOTAL	100.9	509.4	14.9	8.8	4.3	11.1	57.1	224.6	13.6		1.7	23.2	4.9	12.9	10.8		24.0	376.5	1.7	.8	1.0	34.5		6.0
CRUSTACEA																								
Unidentifiable		3.2		.9	.5	2.2	.4	6.1						.3		2.9	.2	14.2			.1	68.1		
Crab	6.5	31.6		.2	.2	.8		.4				2.7		.4								2		.3
Lobster		.7			.1	.1		.2																
TOTAL	6.5	35.5		1.1	.8	3.1	.4	6.7				2.7		.7		2.9	.2	14.2			.1	68.3		.3
BONE																								
Bird	7.9	58.3			1.5	6.4		.1	.3			.2	89.8	3865.9	.2	23.2	1.4	25.7				4.2		8.6
Dog		3.9															.3							
Fish	43.3	427.0	.3	1.2	3.5	2.7		7.6	.2			.2	.3	.7	1.0		3.5	61.4		.2	16.8	271.8	.8	1.6
Pig	26.9	117.5																5.3				7.5		
Human																								
Rat	.8	4.9		.1	.2	.3		2.8	.4					6.7	.1		.2	3.3				.6	.2	.2
Cow																	73.2	9.4						
TOTAL	78.9	610.2	.3	1.3	5.2	9.4		10.5	.9			.4	90.1	3873.3	1.3	23.2	78.6	104.1		.2	16.8	284.1	1.0	10.0
MISCELLANEOUS																								
Charcoal	96.4	307.9	.3	4.6	.6	15.9	11.7	70.0	8.5				.1	4.2			1.7	75.1	5.2	.6	11.5	78.9	4.3	14.3
Kukui	61.0	51.8			14.3	10.5		.1									.7	5.4				1.5		.3
Seeds													.6											
Basalt	533.2	148.8				78.0		66.3						3.9				45.5			434.2	17.1		63.8
Coral	16.5	7.5	.8				32.4	54.4			.6				15.5	7.1	6.5	30.7						
Egg shell																								
TOTAL	677.1	515.9	1.1	4.6	14.9	104.4	44.1	190.8	8.5		.6		.7	8.1	15.5	7.1	8.9	156.7	5.2	.6	445.7	95.5	4.3	77.7
TOTAL MIDDEN WEIGHT (STRATUM)	2156.3	6600.2	739.9	1151.2	437.0	1109.8	148.8	681.1	180.1		87.4	682.0	121.9	2304.2	41.6	39.4	601.7	5341.5	12.3	7.0	477.2	694.9	7.8	246.[illegible]

BY WEIGHT FROM EXCAVATED SITES

2730		2731		2732		2745		2763		3663		3682		2768		2777		2778		2784		2786		2787		2789		2790		2517	
I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
2.2																															
													9.2											6.9	9.2						
2.0	30.5	11.9	7.0	14.5		30.5	109.3	1.9	3.1			16.2	140.8				51.6		59.5				89	45.7	85.7			23.9	34.7		
			.9									2.0	3.9																		
28.5	82.1	1.6		7.7		22.8	59.2	3.8			6.1	3.2	45.3			1.1	32.6		14.5			67.1	71.1	37.0	283.8	10.2	146.6	35.4	59.6		
													9.1																		
6.2	20.0		.2	3.8		4.8	96.9		1.6			10.0	46.9				1.5					3.7			5.4		5.6	3.9	9.7		
1.1																	6.2	.2	.3									.6			
1.3	.7																														
.2	6.5	.2	.3			.8	1.1	.4	22.2		.1	1.7	4.7				2.8		.5			.4	.6	.3	4.1			.1			
307.5	466.7	12.9	138.4	122.9		23.3	372.3	13.7	346.7	.2		402.7	3968.9			1.1	14.8		.9			45.9	43.7	33.2	2790	10.6	742.8	49.4	171.0	1.0	23.8
																								4.5							
													12.1																		
																											5.8				
			6.1																												
		1.8	2													7.9	.4		.7			10.0	32.0		1.7		.9				
3.4	7.1		16.8			.2	2		4.1			3.9	44.9			1.4	16.5	1.6	82.4						3.9			2.2			
352.4	612.5	28.4	169.7	154.9		82.4	639.6	19.8	380.6	.2	6.2	439.7	4304.8			11.5	120.8	1.8	144.3			127.1	156.3	127.6	672.5	20.8	901.7	115.5		1.0	23.8
									5.0																						
32.9	287.2	.1				.2	1.5		.4	1.4		20.2	163.2			.3	107.1		.4					.8	12.0	1.1	125.7	5.4			
												10.9	26.6	.1	.1		56.4		4.7			3.8	3.1	4.5	22.2	1.0	9.6	9.1			
11.8	11.4	5.4	28.4			2.1	11.2	.2				1.2	8.9				3.9		.8				5.1	.8	10.2		2.6	9.8			
	.2		3.4							12.4		18.0	84.3	5.3	5.3	1.8	169.8		1.6			4.2	1.1	11.2	83.6	3.6	65.1	9.1			1.7
14.7	68.7	13.3	47.0	2.2		.4	3.4	6.2	22.2																						
																											.9				
39.4	368.0	16.8	78.8	2.2		2.7	18.1	6.4	28.6	13.8		50.3	383.0	5.4	5.4	2.1	337.2		7.5			8.0	9.3	17.3	128.0	5.7	203.9	33.4	72.7		1.7
.6			.5			.1	3.0	.2	1.4			.6	16.9			.1	7.6		.1				.6		3.7			.2	6.0		.8
2.8	9.7	54.9	182.3	12.0		.2	9.0	2.9	9.9	1.3		19.3	276.6				20.7	.7	5.9									20.1	8.7		
	1.1						.5						7.8		.5	.3								3.6	6.1	1.0		.8	2.3		
			.1																								.4		5.8		
.3	1.3	2.2	41.7	1.6		1.4	10.5	1.8	1.6	9.5		4.1	73.2	1.7	.3	.6	6.2					8.6	10.6	12.0	247.8	.1	35.8	5.9	43.7		4.0
4.3	11.1	57.1	224.6	13.6		1.7	23.2	4.9	12.9	10.8		24.0	378.5	1.7	.8	1.0	34.5		6.0			8.6	11.2	15.6	257.6	1.1	38.2	37.0	77.5		4.8
.5	2.2	.4	6.1						.3		2.9	.2	14.2			.1	68.1														
2	.8		.4				2.7		.4								.2		.3					1.6	9.9		3.5		10.7		3.2
.1	.1		.2																												
.8	3.1	.6	6.7				2.7		.7		2.9	.2	14.2			.1	68.3		.3					1.6	9.9		3.5		10.7		3.2
1.5	6.4		.1	.3			.2	89.8	7885.9	.2	23.2	1.4	25.7				4.2		8.6		.6			.2			1.8	1.0	108.7		.8
												.3																	1.2		
3.5	2.7		7.6	.2			.2	.3	.7	1.0		3.5	61.4		.2	16.8	271.8	.8	1.6				.4	1.8	149.2		2.5	1.7	30.2		
													5.3				7.5								.4			1.4	1.6		
																									.3						
.2	.3		2.8	.4					6.7	.1		.2	3.3				.6	.2	.2				.2	.5	9.0				1.2		
												73.2	8.4																		
5.2	9.4		10.5	9			.4	90.1	7873.3	1.3	23.2	78.6	104.1		.2	18.8	284.1	1.0	10.4		.6		.6	2.5	179.9		4.3	4.1	159.7		.8
.6	5.9	11.7	70.0	9.5				.1	4.2			1.7	75.1	5.2	.8	11.5	76.9	4.3	14.3			.2	3.3	35.0	81.6	6.3	17.3	25.2	465.1		4.7
14.3	10.8		.1									7	5.4				1.5		.3					10.5	23.8			9.9	2.6		
								.6																2.5	6.9						
	78.0		66.3						3.9				45.5			434.2	17.1		83.1						25.5						
		32.4	54.4			.6				15.5	7.1	6.5	30.7											6.0	126.3			49.5	40.8		
																									1.9			.2	36.9		
14.9	104.4	44.1	190.8	8.3		.6		.7	6.1	15.5	7.1	9.9	156.7	5.2	.8	445.7	95.5	4.3	77.7			.2	5.3	54.0	1376.9	6.3	17.3	84.8	544.6		4.7
437.0	1109.8	148.8	681.1	180.1		67.4	662.0	121.9	2304.2	41.6	39.4	601.7	5341.5	12.3	7.0	477.2	894.9	7.8	246.7		.6	143.8	180.7	218.6	1624.5	33.9	1166.3	274.8	1127.1	1.0	39.0

2

information given in Table 3 but was not used because gross weights were proven to be sufficient criteria for intersite comparison. Presence and absence of the terrestrial midden components, bird bone, pig, dog, and kukui nut shell, were more relevant to intersite comparisons and are a more significant indicator of change in human exploitation patterns than comparison of shellfish ratios.

Midden associated with a prehistoric (?) buried A3 horizon (Stratum II) was present in all the archaeological sites salvaged except Sites 9669, 2780 and 2781, 2784, 2791, 2797, 2604, 2609, 2620, and 2621. Midden from 17 archaeological sites was sent to the laboratory to be sorted, weighed, and analyzed. Results of the quantitative analysis are presented in Table 3 and shown graphically by site in the Archaeological Excavations - Summary of Excavated Sites section of this report.

With the exception of Site 2763 the remains of marine invertebrates comprise over 50 percent of the total food refuse, quantified by weight, for each site. This component (shellfish) includes molluscan shells and fragments, echinoderm spines and skeletal parts, and crustacean pincer fragments. The shellfish species present in the midden from all sites can, without exception, be collected from shallow water or littoral habitats.

The remainder of each site's total midden is comprised of animal and plant material and basalt and coral manuports. Bone material (excluding bone artifacts) is predominantly fish and bird, but pig bone is found in Sites 2712, 9682, and 2787, and dog bone in Sites 2712 and 2795. Midden from Site 2763 is predominantly bird bone with lesser quantities of Nerita picea and fish bone. Egg shell is also present in Sites 2787 and 2795. Aside from charcoal, plant remains are limited to a few kukui (Aleurites moluccana) nut shell fragments.

A major problem confronting the archaeologist in Hawaii is determining which habitation sites are the result of permanent rather than temporary or seasonal human occupation. Resolution of this problem has been possible to a degree in archaeological sites where multiple chronometric dates are available from single sites (Green 1970:102). In the absence of such chronometric dates in the present study areas an attempt to define other criteria for solving this problem was made using the frequency (by gram weight) of five (5) genera of molluscs (Nerita, Brachidontes, Isognomon/Pinctada, and Tellina) which constitute the bulk of the shellfish component of the Barber's Point middens. The hypothesis is based on the concept of "cultural transforms" operating in the process of midden formation (Kirch 1979:118) and is summarized below.

Feasible exploitation of the maritime resources (i.e., fish and shellfish) for subsistence at any given time by a group inhabiting a given area on a permanent basis is largely dependent upon natural phenomena, including phases of the moon and time of day or night of accompanying tides, the seasonal and weather, all of which affect change in habits and movements of fish populations.

Assume first, that the permanent inhabitants (the exploiters) possessed an intimate knowledge of the habits and movements of the fish populations sought after, as well as an efficient fishing technology and, second, that exploitation of fish species was preferred and surpassed exploitation of shellfish species. Further, littoral and inshore shellfish collecting probably occurred or was intensified when fish were unavailable or available in insufficient quantities, i.e., during storms or periods of high swells. The archaeological expression of permanent occupation therefore is hypothesized to be predominance of littoral and secondarily inshore dwelling shellfish in the habitation site midden. That is, permanent occupation demands more intensive exploitation of littoral and inshore resources for subsistence.

Conversely, temporary habitation sites would exhibit very different characterisitics assuming they are are a product of specialized activities such as seasonal or periodic fishing which would correspond to spawning or schooling periods when large quantitites of certain species could be caught, prepared, and possibly transported to other locations. The characteristics to be expected are a predominance of fishbone midden derived from few dominant species and correspondingly low quantites of shellfish remains.

Customary practices in the 1940s in Western Samoa as related by Mrs. Betty Muagututi'a Ching (personal communication 1980) provide a logical explanation for a differential deposition of Nerita to fishbone in permanent occupation sites. Simply stated, Nerita collection was intensified when fish were not to be had. Nerita shells were commonly disposed of by scattering the shells a..ng the 'ili outside the house structure, unlike fishbone which was commonly discarded in the ocean (personal communication Mrs. Betty Muagututi'a Ching). The rational for this was that Nerita shells are not uncomfortable or dangerous to walk on and do not distract from the clean appearance of the residence. This was the basis for selection of littoral and inshore dwelling genera of shellfish for testing.

The midden component of Site 2777 is predominantly fishbone while shellfish are virtually absent. Thus, this site would exemplify a temporary habitation site.

Site 2732 exemplifies the opposite extreme, that is, a permanently occupied site where Nerita is the predominant midden component and fishbone density is lower. In the case of Site 2763, midden is comprised predominantly of bird bone but contains significant quantities of Nerita and small amounts of mammal and fish bone. Hypothetically, this indicates a degree of permanence for occupation of the sink.

In order to test the hypothesis statistically, the coefficient of correlation was calculated for each of the four (4) genera of shellfish to fishbone in Stratum II by site. The expected outcome, an inverse correlation of Nerita to fishbone, was not realized however, (see Table 4) although Nerita to fishbone has the least positive correlation. Unexpectedly, Isognomon/Pinctada and Tellina to fishbone show a strong positive correlation. The significance of this correlation is not clear at this time but the following two (2) facts should be considered: (1) Tellina (and Cypraea) is a predominant fossilized shell on the emerged reef; and (2) Isognomon and Pinctada are often used in the manufacture of fishhooks.

In spite of the negative results of the statistical test for inverse relationship of shellfish to fish bone, further testing of the hypothesis could show that the middens comprised an inadequate sample or that other variables must be taken into account.

The cultural middens from the Barber's Point sites in our study areas conclusively show that 14 major structural features and three

(3) sinks were the primary foci of human habitation. Distribution of midden materials within each site is not random; rather concentrations of midden form distinct patterns which define activity areas associated with intra-site features, especially hearth areas and entrances to the enclosures (refer to Archaeological Excavations section). Heavy reliance upon maritime resources is indicated, however, terrestrial resources are likely to be underrepresented in the midden as are marine flora due to natural processes of organic decay.

Intrasite variation in midden quantities and components between different levels of Stratum II were discernible in the field to the degree mentioned in Archaeological Excavations (this report). The extreme irregularities in thickness of this unit are due to its compressed and mixed nature resulting from natural and cultural causes. Generally, the natural causes are surface erosion and entrapment of sediments by the sinkholes thus deterring the build-up of thick surface deposits and creating reworked accumulations of cultural materials (and fossils). The cultural cause being continued or reoccupation upon an earlier deposit.

Intersite variability in the midden among the habitation sites studied (refer to Table 3) is most evident in the category of mammal bone. This contrasts with the relative consistency of shellfish (including sea urchins and crusteaceans) in the middens. The presence of pig, dog or unidentified mammal bone debitage is present in all habitation sites (except 2723, 2732, 2745, 9669, 2768, 2786 and 2617). This means that all sites without mammal bone are in the class of shelters and hale moe as defined by other criteria (midden, artifact densities, hearths and size and structural traits). Presence of mammal bone in four (4) examples of the shelter class of sites could be due to temporal or social status differences. The absence of mammal bone could also indicate early occupation and abandonment, but in the case of Sites 2768 and 2786, this and the general lack of midden are used to define criteria for interpreting these sites as hale moe.

Presence, absence or amount of bird bone in a site can be useful as a relative time indicator if a chronometric sequence of extinction for the prehistoric avifaunal of Kalaeloa can be established. While this has not been accomplished yet, identification of the bird bones derived from the cultural deposits has shown them to be universally Pterodroma phaeopygia (dark-rumped Petrel).

The presence of a variety of reef fish including parrot fish (uhu), wrasse (hinalea), procupine fish (kukala), trigger fish (humuhumu), file fish ('o'ili) and surgeon fish (kala, pualu, palani, paku'iku'i, manini, etc.), is evidenced by jaw fragments, dental plates and palates, spines and the knife-like plates of the surgeon fish. Vertebrae from shark or ray are present in 2787 and 2745 and fragments of large toothed jaws, tentatively identified as crevally (ulua) are present in Sites 9682 and 2745. All of these fish may be taken by hook and line or net fishing in shallow reef environments. A dense concentration of dorsal spines of 'o'ili (Stephanolepis spilosomus or S. princei (Jordan and Evermann 1973) and other fish bone and scales were present adjacent to an interior hearth at Site 2777 (refer to Archaeological Excavations herein). This species is represented in many of the surface habitation sites but the deposit in 2777 is unique in the project area.

In her book on the native use of fish in Hawaii, Margaret Titcomb wrote,

> According to an informant for J. and E. (40, p. 421), [D. S. Jordan and B. W. Evermann], . . . this fish ('o'ili uwiwi) ["]comes occasionally in great numbers but otherwise is very rare. The natives believe its appearances to prophesy the demise of some great personage, such as a king or a chief.["] In the spring of 1944, they were observed in great numbers, millions of them all along the beaches of southeastern Oahu. They seemed to already dead when they floated ashore and piled up on the beaches. This continued for many weeks. Many persons tried to lay the cause to wartime occurrences at sea, but is likely that the cause had nothing to do with the war . . . .
>
> Evidently they were sometimes eaten. In 1862, Kepelino says (52) "The skin is peeled off and thrown away, and then they are eaten raw or broiled. This is a fleshy fish, not many bones. (Those washed ashore in 1944 were exceedingly compressed in form, about 3 to 4 inches long, and the flesh must have been of trifling account.) It is a fish used in the idol workship of worthless people in times past and some are still indulging in the practice." Mrs. Pukui says, "In Ka'u they are sometimes blown ashore in times of strong gales, gathered for fuel, as they have little food value. In Oahu they were eaten." (Titcomb 1972)

The possibility that the remains in this site result from their use in worship seems unlikely but cannot be ruled out on the basis of the archaeological data. Nevertheless, it seems more appropriate to attribute them to cooking or eating activities. Sinoto (1976:87) tested Site 2777 and recovered a single basaltic glass flake from the modern A horizon. This flake was assigned a calendar year date of 1801. Albeit this single flake does not provide certain proof of the age of the Stepahnolepis sp. deposit in 2777, however the date and the relatively high density of the deposit allow for the tentative conclusion that this is archaeological evidence for a previous occurrence of the events observed in 1944 and as described by Titcomb (1972;above).

TABLE 4

GRAM WEIGHT AND CORRELATION COEFFICIENT OF SELECT LITTORAL AND INSHORE MARINE MOLLUSCS AND FISHBONE MIDDEN

4a. Gram Weight of Midden Components by Site

Site	Nerita Picea	Brachidontes	Isognomon/ Pinctada	Tellina	Fishbone	Total Midden in Stratum II (g)
2712	3064.9	213.8	147.6	257.3	427.0	6608.2
2723	1004.9	--	2.4	6.7	1.2	1150.2
2730	466.7	287.7	11.4	68.7	2.7	1109.8
2731	138.4	--	28.4	47.0	7.6	681.1
2732	122.9	--	--	2.2	0.2	180.1
2745	372.3	1.5	11.2	3.4	0.2	682.0
9682	3989.9	163.2	26.6	184.3	61.4	5341.5
2763	346.7	1.4	--	22.2	0.7	2304.2
2768	--	--	0.1	5.3	0.2	7.0
2777	14.8	107.1	56.4	169.8	271.8	894.9
2778	0.9	0.4	4.7	1.6	1.6	246.7
2786	43.7	--	3.1	1.1	0.4	180.7
2787	279.0	12.0	22.2	83.1	149.2	1624.5
2789	742.8	125.7	9.6	65.1	2.5	1166.9
2790	171.0	17.2	11.8	31.2	30.2	1127.1
2617	23.8	--	--	1.7	--	39.0

4b. Correlation Coefficient

	All Sites	All Sites Except 2712
Nerita to fishbone	.45142	.02668
Brachiodontes to fishbone	.45843	.18702
Isognomon/Pinctada to fishbone	.93930	.85947
Tellina to fishbone	.86309	.73120

Note: Midden totals are for Stratum II only, except for Site 2732.

ARTIFACT ANALYSIS

The artifact assemblage (482 specimens) derived from the salvage excavations of archaeological sites within Study Area 1a and 1b and Optional Area 1 is presented in the Master Artifact Catalog (Appendix IV) with basic provenience and descriptive data.

The types of artifacts in the assemblage are for the most part indicative of traditional, prehistoric (?) Hawaiian occupation and economic subsistence activities. Most organic materials which might have been present at one time would have decomposed in the exposed sites so the artifacts recovered are composed of bone, shell, coral, limestone, sandstone, and basalt, as well as metal and glass from historic sites. Table 5 summarizes the frequency of artifact types by site and stratum. As is evident in this table, there are an insufficient quantity of artifacts in each functional category to allow statistical analysis for defining distribution patterns in relation to midden and other cultural variables. The site by site analysis is presented graphically by density contour maps for each site and is used as one of the criteria for intersite comparisons.

One hundred thirty-five (135) or 28 percent of all the artifacts were recovered from the historic component (Stratum I) of the sites. Thirty-nine (39), or about 8 percent, of the total assemblage are of historic manufacture and 443, or 92 percent, are traditional Hawaiian tool forms.

The stratigraphy and the absence of nonportable artifacts within Stratum I in all sites (except at Site 2712), imply that the traditional artifacts present in Stratum I are derived from Stratum II by mixing. This mixing is a result of the various modern human activities which occurred in the study area after abandonment of the prehistoric (?) sites. These modern disturbances consist mostly of cattle-grazing, bulldozing, military training activities, and kiawe logging.

Modern usage associated with the recent A1 horizon (Stratum I) is evident at Site 2712 where military occupants left portable and nonportable artifacts and refuse superimposed on the prehistoric layer.

TABLE 5 FREQUENCY OF ARTIFACT TYPES BY SITE AND STRATUM

SITE	2712			2723		2730		2731		[illegible]	2763		3669	3672	
ARTIFACT TYPE / STRATUM	I	II	IN WALL	I	II	I	II	I	II	I	I	II	I	I	II
FISHHOOKS															
Bone		7													
Shell				2			1	3	5						2
FISHHOOK BLANKS, PREFORMS AND UNFINISHED FISHHOOKS															
Bone		8		1		1									
Shell		2					1		2						
DETRITUS															
Bone	3	15				2	1		1		1				10
Shell	1	4		5	3				2						
ABRADING TOOLS															
Coral Abraders	2	2		1	1				1					1	4
Coral Files	31	62	1	2	2	3	3		16			3			14
Shell Drills		1													1
Sandstone/Limestone Drills															
Basalt Abraders	1	1													
Basalt Drills															
Sandstone Abraders															
CUTTING TOOLS															
Basalt Saws		1													
Coral Saws	1	3							3		1	2			2
Limestone Flakes	3	2				1		1	2				1		
Sandstone Flakes	1	1							1						1
Basalt Flakes	8	6													
Basaltic Glass									2					3	48
Adz Flakes		2													
Shell Knife									1						
FLAKING AND GRINDING TOOLS															
Hammerstones															
Basalt	2														
Coral															
Grinding or Whetstones															
Basalt															
Sandstone												1			
HISTORIC MATERIAL															
Metal	8	7	9	2						1				1	1
Glass														3	1
MISCELLANEOUS															
Turtle Shell Fragments		1													
Bone Picks	1	1											1		
Limestone Awls					1										
Shell Beads															2
Shell Scrapers															
Hematite Flakes									3						
Firecracked Basalt	1														
Basalt Pebbles/Cobbles			1												
Kiawe Wood Fragments														1	
Basalt Core	1														
Limestone/Sandstone Cores	1														
Porites Coral Pebble								1							
Sandstone 'Ulu maika						1									
TOTAL PER SITE, PER STRATUM	65	126	11	13	7	8	6	5	41	1	2	6	2	9	87
TOTAL PER SITE	202			20		14		46		1	8		2	96	
TOTAL															

*Note: Artifacts from upper and lower boundaries of Stratum II are included with

	2					3	48																
	1																						
				1																			
		1				1	1					1											34
						3	1																4
					1																		
							2									1							
																			1				
	3																						
																		1	1				3
						1																	1
																1							
1																							
														1									
5	41	1	2	6	2	9	87	0	8	0	3	1	1	2	5	34	2	1	11	8	13	3	
46		1	8		2	96		8		3		1	3		42			12		21		3	482

of Stratum II are included with that Stratum.

2

At Site 2723 a metal teapot was found lying upon the surface probably left behind by kiawe loggers. At Site 2795 a military 10-gauge shotgun shell casing was found on the ground surface at the rim of the sink. Modern usage is evident at Site 2791, an historic railroad berm with remnant tracks and ties. At Site 9682, a fragment of straight fence wire and a few glass bottle sherds and cow bone indicate reuse of the prehistoric (?) site on a very temporary basis by nā paniolo (cowboys).

Prehistoric (?) Hawaiian settlement is associated with a buried A3 horizon in every site where traditional tools are found. Patterns in portable and nonportable artifact distribution are discernible. Some of these patterns are repeated from one site to another among the habitation features. Hearths and structure entranceways are the foci of intra-site activity areas. Intersite relationships (among habitation sites) are not indicated by the artifact assemblages except at Sites 2786, 2787, and 2790. Those three (3) sites could comprise a kauhale or a traditional family habitation complex since they are closely associated spacially and have significantly different artifact assemblages, and in addition, are also interconnected by nonportable (structural) artifacts. This could indicate dependent relationships and contemporaniety. Other habitation sites possess assemblages similar to each other which could indicate that they functioned as independent, noncontemporaneous habitations. Selected artifacts are illustrated in Figures 80 through 87.

A brief description of artifact types, including brief comments on their significance follows:

Fishhooks

Evidence of the manufacture of fishhooks (finished or unfinished fishhooks, fishhook blank preforms or cut shell or bone) is present at all habitation sites except Sites 2732, 9667, 2617, and 2786. As shown in Table 5, Sites 2712, 2731, 2787, and 9682 have a considerably higher frequency of occurance of fishhook-related artifacts than do the remaining habitation features. Within this group of sites it is evident that the occupants of Site 2723 (where no mammal bone was found) and

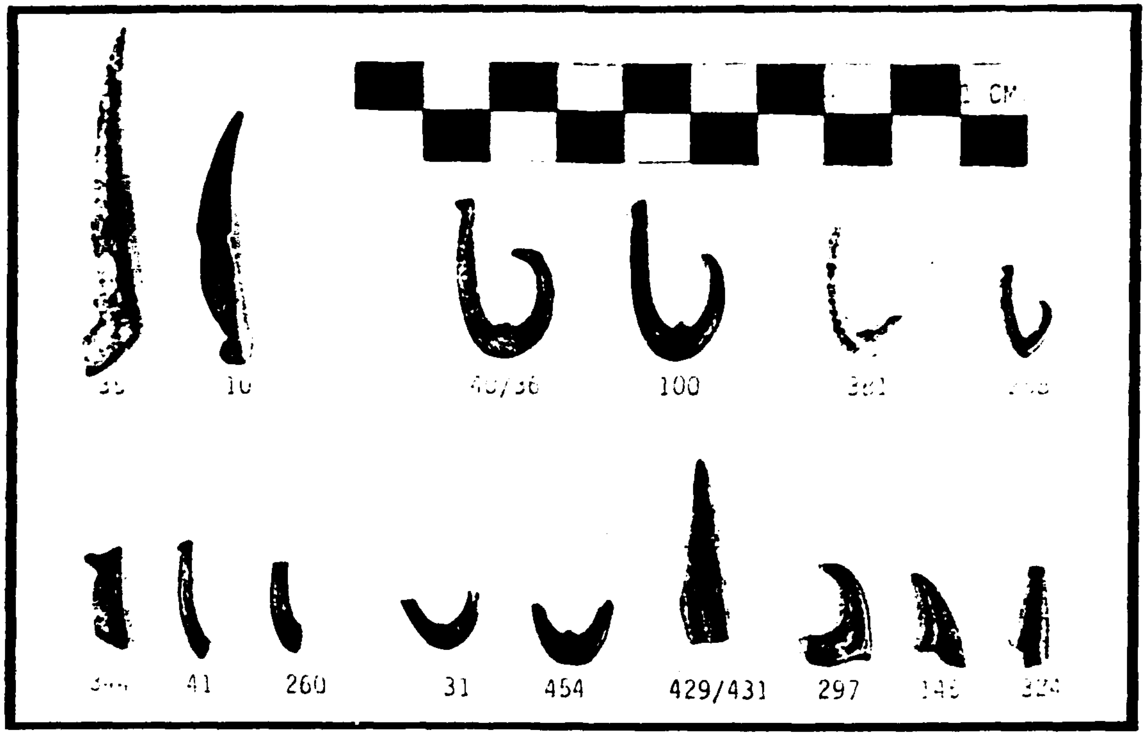


FIGURE 80 BONE FISHHOOKS AND FISHHOOK FRAGMENTS FROM BARBER'S POINT SITES

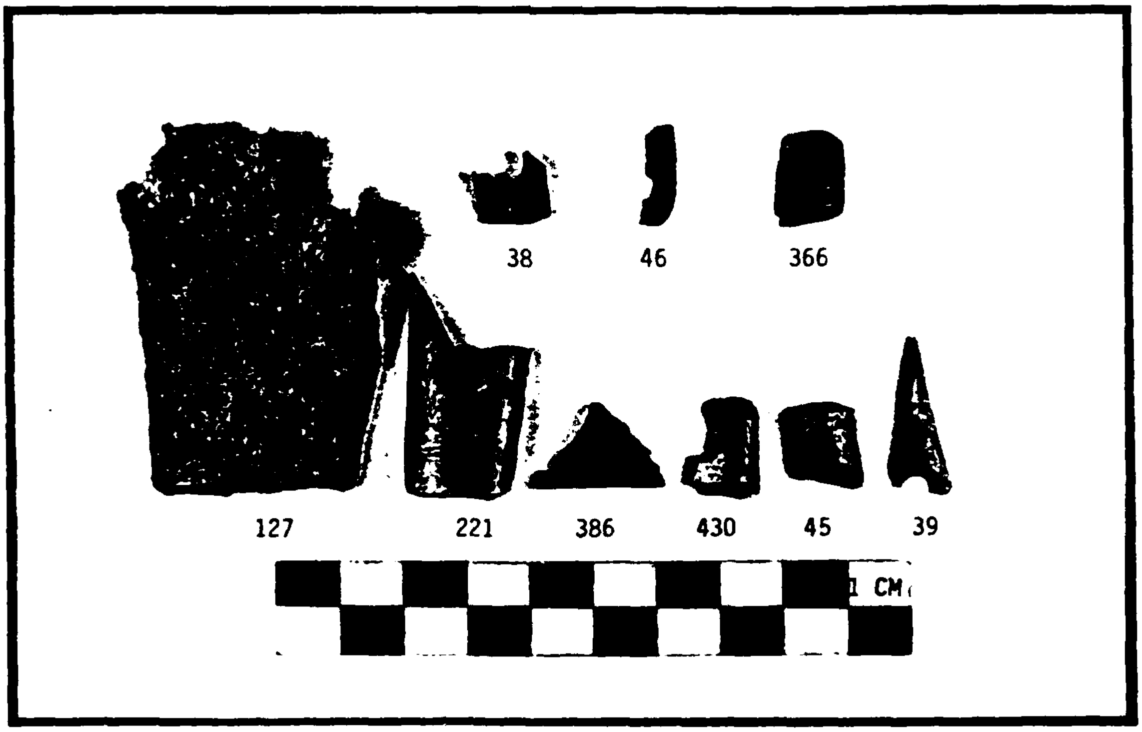


FIGURE 81 MAMMAL BONE FISHHOOK BLANKS, PREFORMS, AND DETRITUS FROM BARBER'S POINT

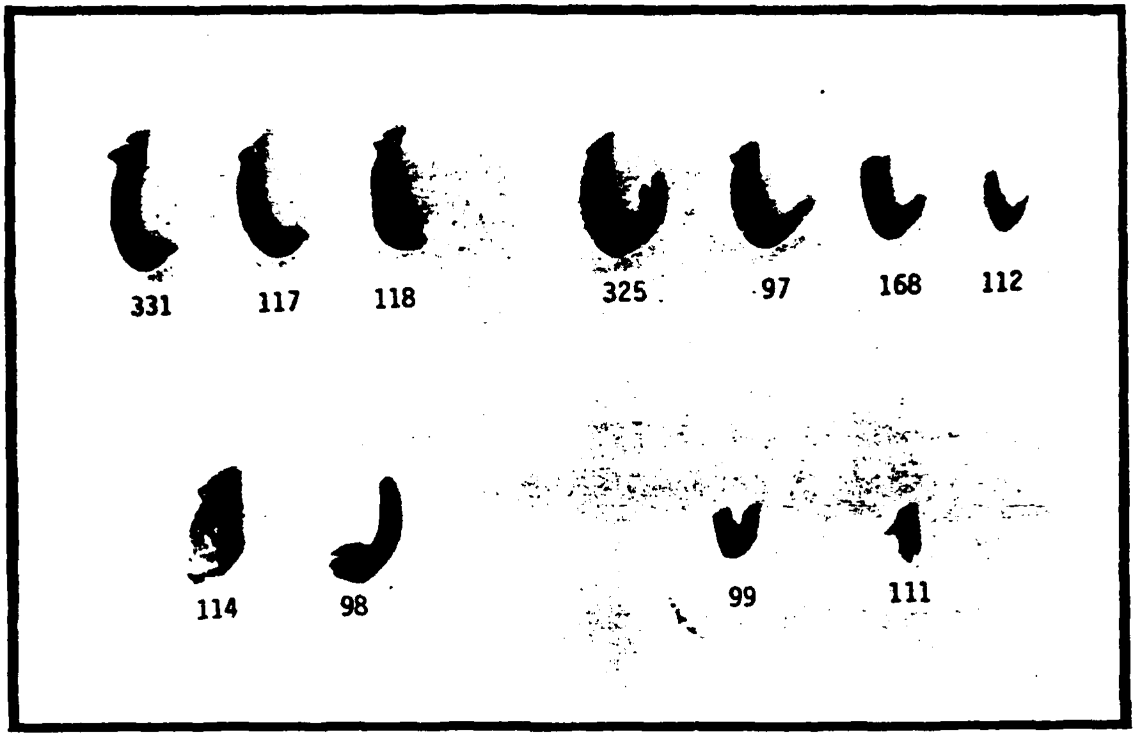


FIGURE 82 SHELL FISHHOOKS AND FISHHOOK FRAGMENTS FROM BARBER'S POINT SITES

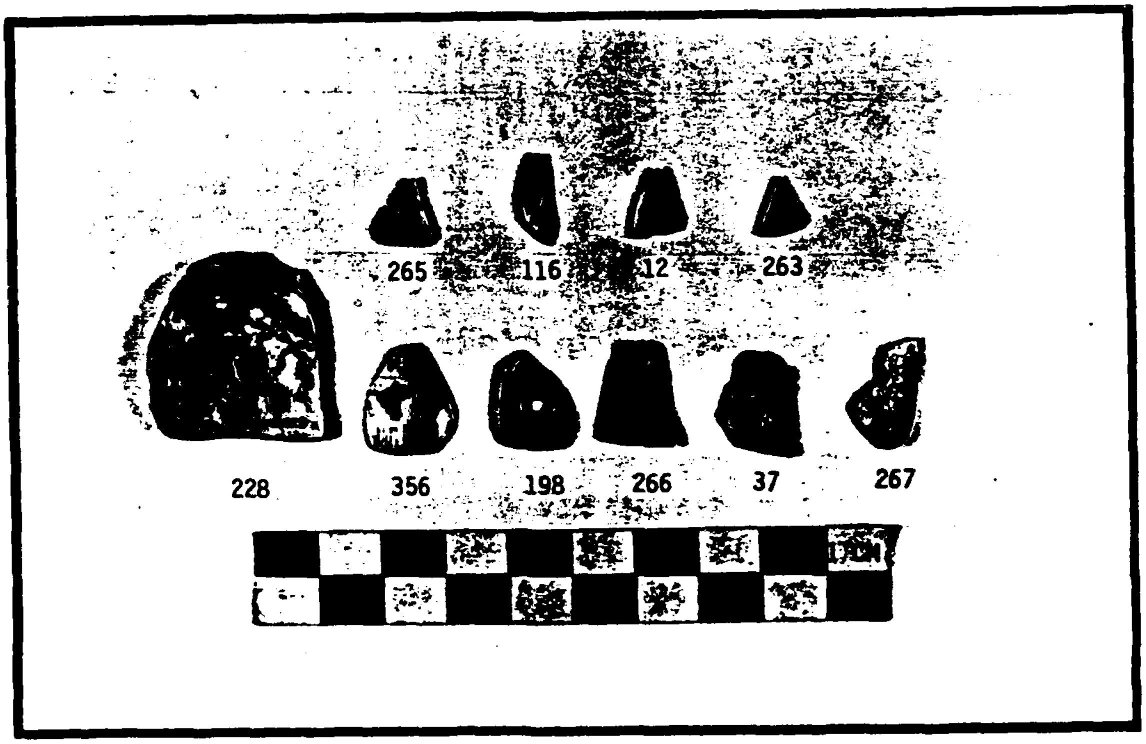


FIGURE 83 SHELL FISHHOOK BLANKS AND PREFORMS FROM BARBER'S POINT SITES

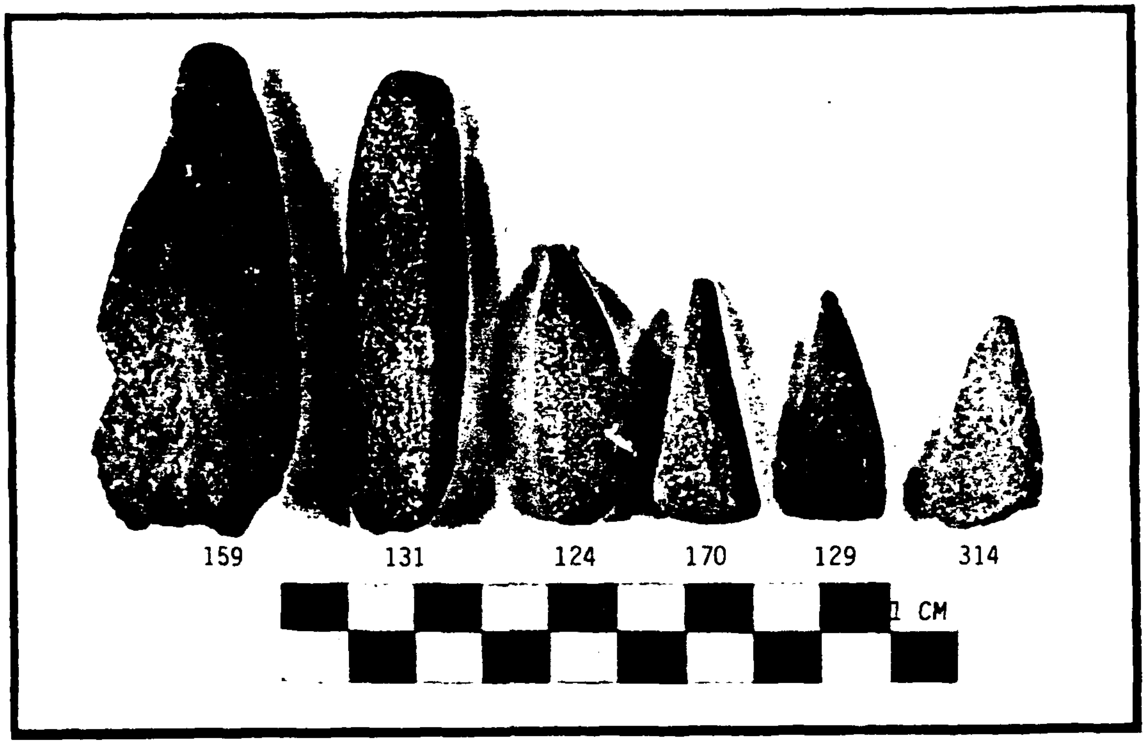


FIGURE 84 REPRESENTATIVE SAMPLE OF CORAL FILES FROM BARBER'S POINT SITES

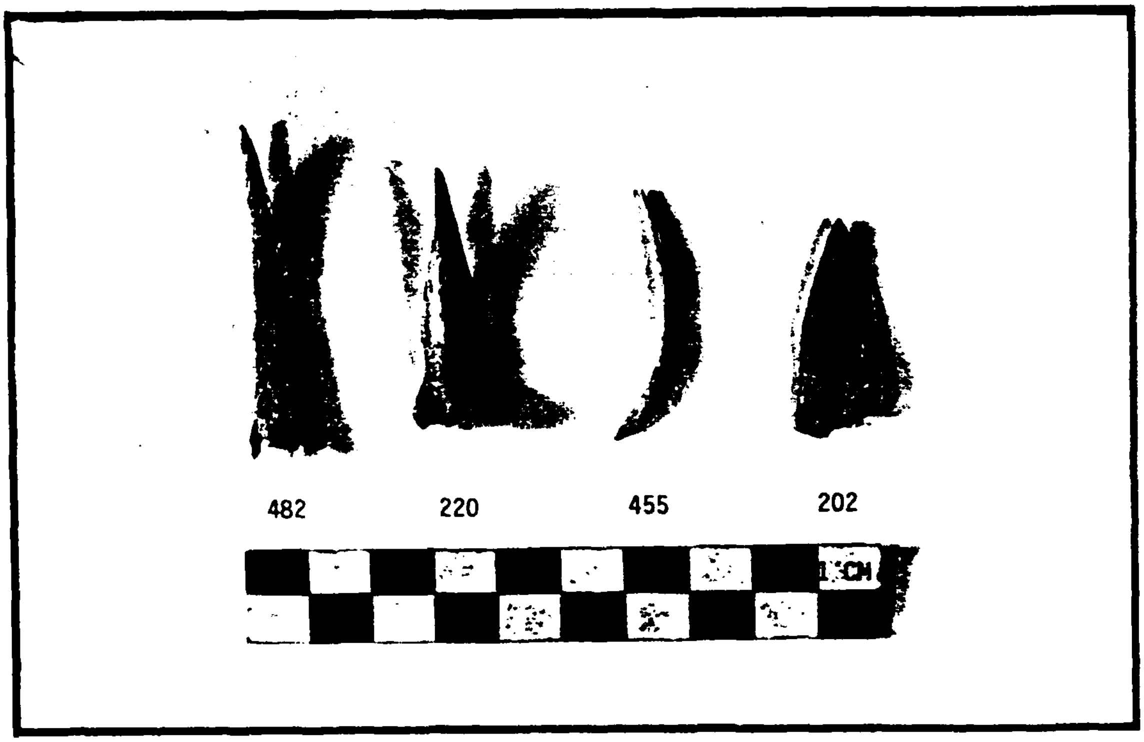


FIGURE 85 BONE PICKS OR AWLS FROM BARBER'S POINT SITES

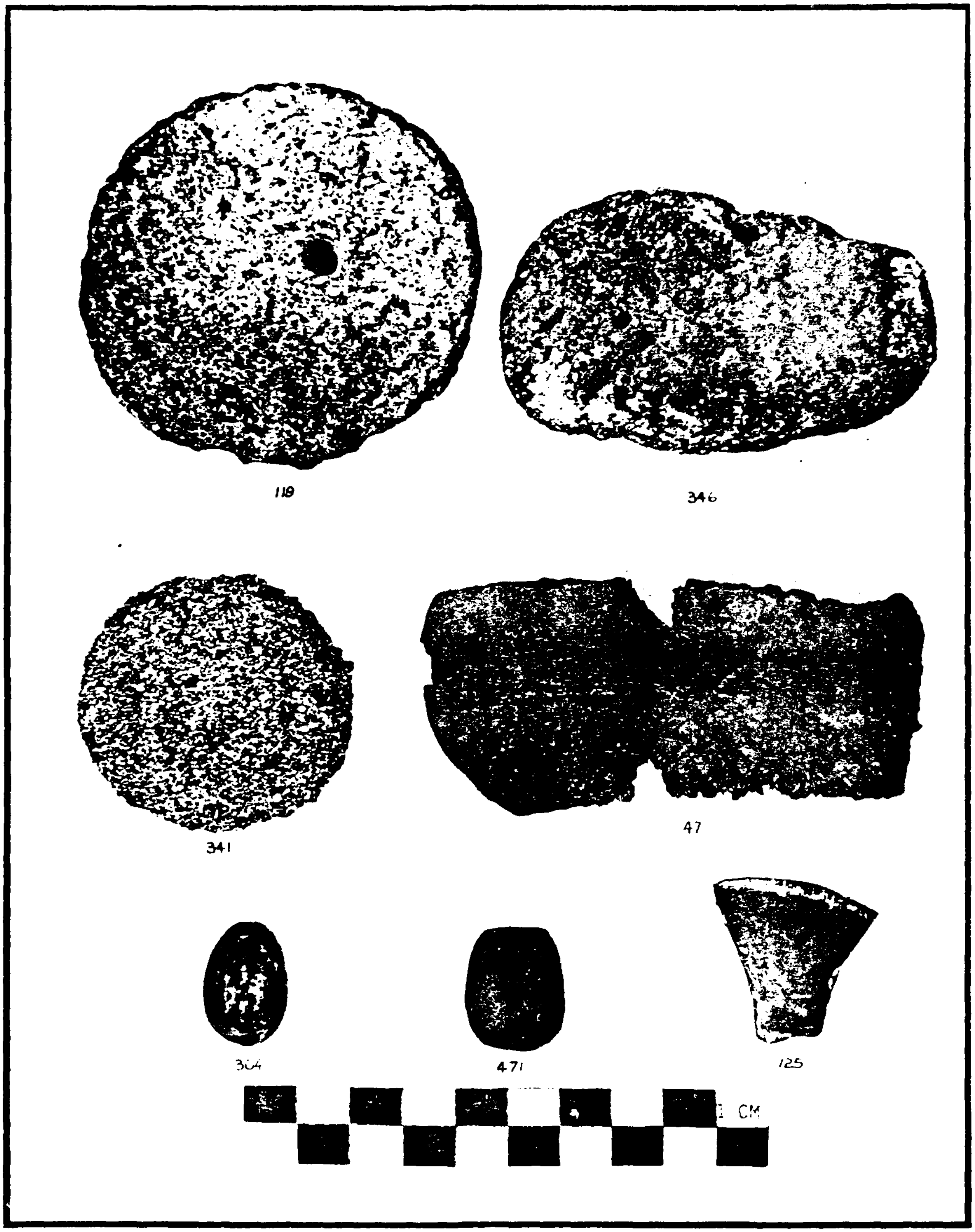


FIGURE 86 REPRESENTATIVE SAMPLE OF MISCELLANEOUS ARTIFACTS FROM BARBER'S POINT SITES

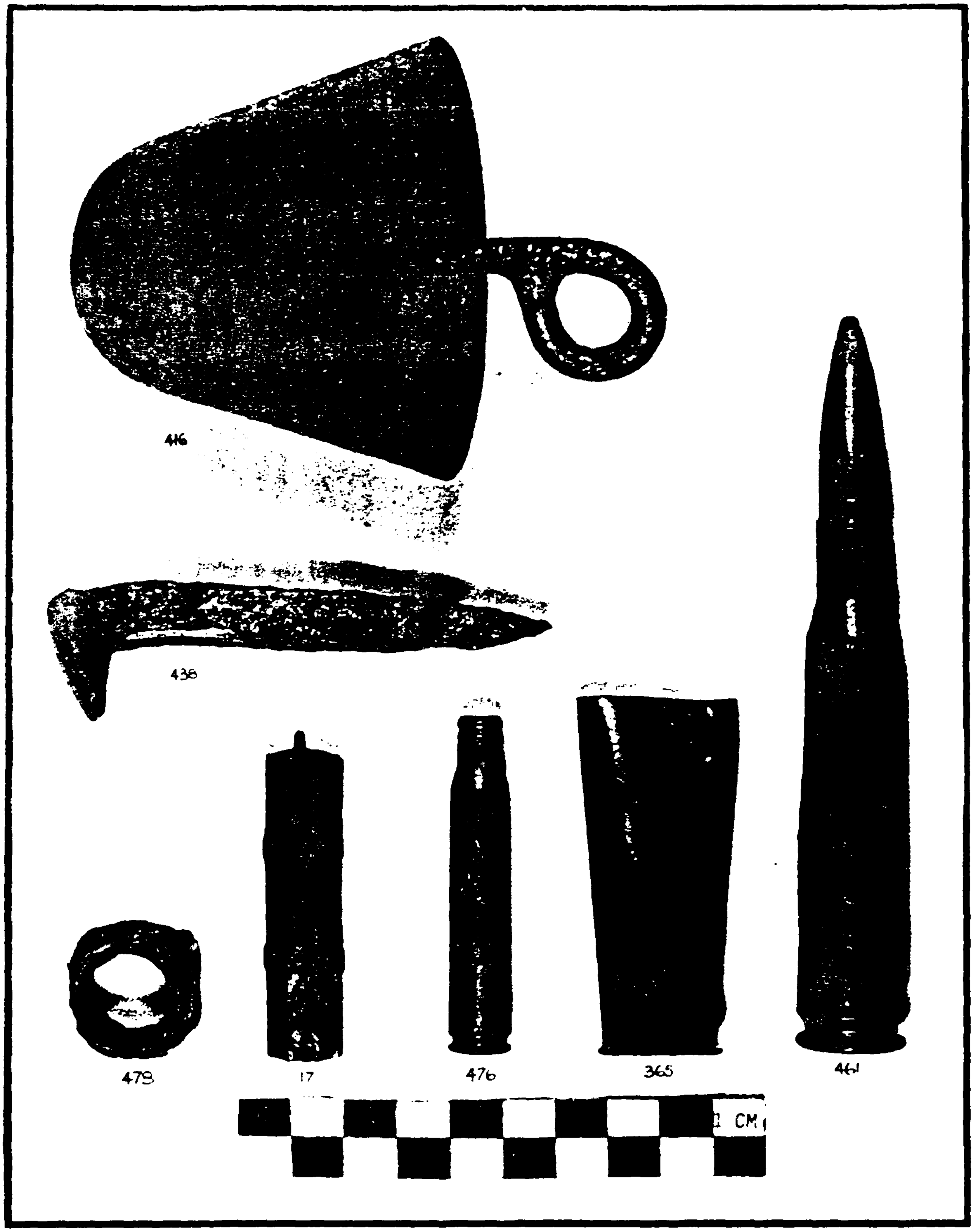


FIGURE 87 REPRESENTATIVE SAMPLE OF HISTORIC ARTIFACTS FROM BARBER'S POINT SITES

of Site 2731 (where one bone fishhook was found) prefered Pinctada radiata and Isognomon spp. for raw material in fishhook manufacture, while the occupants of Sites 2712, 2787, and 9682 preferred mammal bone for fishhooks, although, in the latter three (3) cases, shell was utilized to a lesser degree.

Fishhook style characteristics are noted in coded form in Table 6 by site and provenience. Description of the fishhooks by this method shows that the shank (or attachment) Head Type 1a is the predominant form with only one example of Head Type 4 on a bone fishhook from Site 2787. Of the 29 fishhooks and fishhook fragments from all the sites, 10 (or 37 percent of the total) retain the diagnostic attachment head. Head Type 1a is considered to be stylistically older than Head Type 4 (Emory, Bonk, and Sinoto 1968:60), nevertheless they occur together throughout the stratigraphic layers of the South Point (Ka Lae, Hawai'i Island) sites. The small sample size from Barber's Point and the large number of sites from which the individual specimens derive precludes a reliable relative chronology based on fishhook head type.

The assemblage of fishhooks (including blanks and preforms) and detritus from fishhook manufacture indicates a predominance (74 percent of the total) of small to medium-sized one-piece, barbless, jabbing and rotating hooks (refer to Figures 80 through 83). Six (6) hooks or hook fragments (22 percent) are two-piece hooks; all are made from mammal bone and only two (2) specimens retain the diagnostic base part. One of those two (AR 10) is notched; the other (AR 431) is plain. A single composite (octopus-lure hook) point with notched base was recovered from Site 2712 (AR 35). There were no composite bonito-lure hooks present in the excavations.

Abrading Tools

This category of artifact types comprises coral files and abraders, a single basalt abrader, and shell columnella, sandstone, and basalt drills. The frequency of coral artifacts surpasses that of all other

TABLE 6

FISHHOOK TYPE BY SITE AND PROVENAN

Site Number	Accession Number	Provenance Trench	Stratum	One-Piece Bone	One-Piece S
2712	10	N4W1	I/II		
2712	31	N2W2	II	S-IAa(c)	
2712	35	N2W1	II		
2712	36/40	N3W1	II	HT1aIB1(1)a	
2712	41	N3W1	II	HT1aIAa(a,b)	
2712	454	N2W2	II	S-Ia(c)	
2723	324	S1W3	I		
2723	325	N2W1	I		HT1aIAb(a,
2730	331	S1W2	I/II		HT1aIAb(a,
2731	97	S1E1	II		HT1aIAb(a,
2731	98	S1E1	I		IA(1)b(c,d
2731	99	S1E1	I		S-IAb(c)
2731	100	S1E1	II	HT1aIA(1)a	
2731	111	N1E1	II		S-I(2)b(d)
2731	112	N1E1	II		S-IAb(b,c)
2731	114	S1W1	I		HT1aIba(a,
2731	116	S2W1	II		S-IAb(b)
2731	117	S1E2	II		HT1aIAb(a
2731	118	N1E2	II		HT1aIAb(a
9682	145	N1E1	II		
9682	168	N1W1	II		S-IAb(b,c)
9682	297	S1W1	II	S-IA2(3,4)a(d,e)	
2777	268	N1W1	II	S-Ia(c)	
2778	260	S1W2	II	S-IAa(b,c)	
2787	344	N1W1	II	HT4IAa(a,b)	
2787	429/431	S4W2	II		
2790	381	S2E1	II	S-IAa(b,c)	

NOTE: This table uses the classification code for Hawaiian fishooks and fishhook head ty from Emory, Bonk, and Sinoto 1968.

TABLE 6

FISHHOOK TYPE BY SITE AND PROVENANCE

ber	Provenance Trench	Stratum	One-Piece Bone	One-Piece Shell	Composite & Two-Piece Bone	Total in Site
	N4W1	I/II			IID3(1)aAAbl	
	N2W2	II	S-IAa(c)			
	N2W1	II				
	N3W1	II	HT1aIB1(1)a			
	N3W1	II	HT1aIAa(a,b)			
	N2W2	II	S-Ia(c)			7
	S1W3	I			S-IID3a(d)	
	N2W1	I		HT1aIAb(a,b,c)		2
	S1W2	I/II		HT1aIAb(a,b,c)		1
	S1E1	II		HT1aIAb(a,b,c)		
	S1E1	I		IA(1)b(c,d)		
	S1E1	I		S-IAb(c)		
	S1E1	II	HT1aIA(1)a			
	N1E1	II		S-I(2)b(d)		
	N1E1	II		S-IAb(b,c)		
	S1W1	I		HT1aIba(a,b)		
	S2W1	II		S-IAb(b)		
	S1E2	II		HT1aIAb(a,b,c)		
	N1E2	II		HT1aIAb(a,b,c)		10
	N1E1	II			S-IID3(2)a(d)	
	N1W1	II		S-IAb(b,c)		
	S1W1	II	S-IA2(3,4)a(d,e)			3
	N1W1	II	S-Ia(c)			1
	S1W2	II	S-IAa(b,c)			1
	N1W1	II	HT4IAa(a,b)			
	S4W2	II			S-IID3(1)axCCb1(d)	3
	S2E1	II	S-IAa(b,c)			1

ification code for Hawaiian fishooks and fishhook head typology
68.

artifact types combined in the category. They comprise 88 percent of the total number of artifacts classified as abrading tools and 32 percent of the total assemblages from all sites combined. These tools were used primarily but not exclusively for the reduction of bone and shell blanks during fishhook manufacture. The coral file artifacts are generally small and roughly conical in shape with longitudinal faceting derived from use. The length, number, and position of the facets is highly variable between specimens.

Abraders differ from files mainly in size and probably function. Fourteen (14) coral abraders, one (1) sandstone abrader, and two (2) basalt abraders comprise this artifact category. These tools, generally larger than files and therefore having considerably larger abrading surfaces, are probably used in manufacturing or finishing wooden artifacts.

Four (4) specimens identified as drill-bits or awls are (1) a retouched basalt flake from Site 2795, (2) a retouched limestone flake from 2787, and (3) two (2) shell columnella from Sites 2712 and 9682. Evidence of the use of drills is restricted to shell and bone fishhook blanks, which are perforated to form the inner edge of the bend of the hook.

Cutting Tools

Cutting tools in the artifact assemblage consist of coral and basalt saws, limestone, sandstone, basalt, and basaltic glass flakes and polished adz flakes. Many of these tools, except for basaltic glass and adz flakes are in associations which indicate their use primarily to reduce mammal bones into fishhook blanks by means of longitudinal and transverse incisions made upon the bone to direct and control breakage. They were also probably used for working other materials such as wood or shell and might have been used for removing tree bark or leaf fibers for rope manufacture as well.

Basaltic glass is present in Sites 2731, 2787, 2789, and 9682. The specific function of basaltic glass cannot be suggested on the basis of excavation data. It is generally acknowledged, however, that basaltic glass flakes are multi-functional cutting tools.

Polished basalt adz chips, present at Site 2712 only, indicate the use of adzes for woodworking at the site. The absence of adz material in all the other sites could suggest that woodworking was not occurring at these sites; however, the abundant resource of limestone could have been substituted for basalt.

Flaking and Sharpening Tools

This category includes hammerstones and grinding or whetting, stones. Few artifacts of these types were found in the excavations. They are two (2) basalt and one (1) coral, cobble-sized hammerstones, and a small boulder-sized sandstone grindstone deriving from Site 2763.

Naturally occurring limestone rocks and corals probably were utilized at the other Barber's Point sites for hammerstones and grindstones respectively, even though none could be positively identified.

Miscellaneous

Included here is a variety of artifact types and raw materials, including a turtle shell fragment, bone picks, a limestone awl, shell beads (?), shell scrapers, fire-cracked basalt rocks, basalt pebbles, and cobbles, a sandstone core with flake scars, a coral pebble and sandstone 'ulu maika (refer to Figures 85 and 86).

The turtle shell artifact recovered from Site 2712 is roughly rectangular-shaped, measures 1.7 by 3.7 inches, and possibly functioned as a fishnet gauge. Sandstone 'ulu maika were found in Sites 2730 and 2786. The specimen from 2730 is fragmented and both specimens have rough, weathered surfaces. Site 2787 contains evidence of the reduction of sandstone in the form of a cobble-sized sandstone core with flake scars and associated sandstone flakes, displaying relatively clear bulbs of applied force. These miscellaneous artifacts provide additional insights, although perhaps tentative, into other activities engaged in by the human occupants of the sites studied.

Historic Material

Historic material from the sites in the study areas consists of bottle glass sherds and metal objects (including .30-caliber Springfield rifle shell casings and clips, a live .50-caliber machine gun round, tin foil, aluminum fragments, fence wire, rail car track sections and spikes, and an unidentified object associated with the railroad berm site, 2791 (refer to Figure 87). In almost every case, historic material is associated with the recent A1 horizon (Stratum I).

BASALTIC GLASS AND RADIOCARBON ANALYSES

Radiocarbon Dating

Four (4) charcoal samples were submitted for radiocarbon dating to Beta Analytic, Inc. These samples were collected, one each, from Sites 2712, 2777, 2787 and 2790. In all cases they were collected from Stratum II the major intact stratum containing evidence of prehistoric occupation. All of the samples should reflect the early phases of the occupation of these sites. Three (3) of the samples from Sites 2712, 2787 and 2777 were collected as small pebble size chunks distributed within an approximately 50 centimeter radius. The sample from Site 2790 was taken from the charcoal fill of a hearth at the 30 to 40 centimeter level of Stratum II in Trench S2W1. The sample sizes ranged from 8.6 grams to 33.4 grams. In spite of the good condition and careful preparation of the samples, as well as their apparently undisturbed subsurface context, all dates were modern or near modern (Table 7). The samples from Sites 2712 and 2790 are modern with an age of 100 ± 60 B.P. for Site 2777 and 105 ± 70 B.P. for Site 2787. The two (2) radiocarbon ages of 100 ± 60 B.P. and 105 ± 70 B.P. could be consistent with the archaeological indications of late prehistoric -early historic age within the standard deviation range indicated. The two (2) modern radiocarbon estimates are less compatible with the probable actual age of Stratum II at these two sites (2777, 2712). This

TABLE 7

BASALTIC GLASS AND RADIOCARBON ANALYSES

7a. Basaltic Glass

ARCH No.	CH No.	Site	Provenience Trench	Provenience Level In cm.	Provenience Stratum	Average Rind Measurement In Microns	BG Years BP at 10 Microns = 1000 Years	BG Years BC, AD
272	14	9682	S2W1	25-30	2	2.975	298±25	1677±25AD
272	14	9682	S2W1	25-30	2	3.7	370±37	1605±37AD
294	12	9682	S1W1	10-20	2	4.28 (d)*	428±22	1547±22AD
294	12	9682	S1W1	10-20	2	9.45 (d)	945±93	1030±93AD
294	12	9682	S1W1	10-20	2	97.75 (v)*	9775±605	7800±605BC
273	13	9682	S2W1	10-20	2	7.9 (?)	790±41	1185±41AD
273	13	9682	S2W1	10-20	2	50.5 (v)	5050±710	3075±710BC
278	9	9682	S2W1	0-10	2	19.95 (d)	1995±219	20±219BC
278	9	9682	S2W1	0-10	2	118.9 (v)	11890±611	9915±611BC
274	17	9682	S2W1	15-20	2	67.95	6795±417	4820±417BC
274	17	9682	S2W1	15-20	2	58.05	5805±817	3830±817BC
274	17	9682	S2W1	15-20	2	5.35 (d)	535±70	1440±70AD
274	17	9682	S2W1	15-20	2	3.75 (d)	375±26	1600±26AD
285	18	9682	S3E1	10-20	2	7.875	788±43	1188±43AD
285	18	9682	S3E1	10-20	2	9.6	960±105	1015±105AD
285	18	9682	S3E1	10-20	2	14.25 (v)	1425±75	550±75AD
285	18	9682	S3E1	10-20	2	10.9 (d)	1090±39	885±39AD
140	19	9682	N1E1	0-10	2	12.96 (v)	1295±186	680±186AD
140	19	9682	N1E1	0-10	2	11.65 (d)	1165±111	810±111AD
293	20	9682	N1W2	5-10	2	2.15	215±21	1760±21AD
293	20	9682	N1W2	5-10	2	6.78	678±61	1297±61AD
306	21	9682	S2W1	10-15	2	33.25 (v)	3325±64	1350±64BC
306	21	9682	S2W1	10-15	2	11.1	1110±117	865±117AD
306	21	9682	S2W1	10-15	2	5.95	595±63	1380±63AD
271	25	9682	S1W2	10-20	2	10	1000±0	975±0AD
271	25	9682	S1W2	10-20	2	9	900±12	1075±12AD
89	26	2731	S1E1	5-10	2	21.6	2160±107	185±107BC
89	26	2731	S1E1	5-10	2	8.95	895±96	1080±96AD

7b. Radiocarbon

ARCH No.	Beta No.	Site	Trench	Level In cm.	Stratum	Feature	RC Years BP	RC Years A.D.
1	1981	2777	S1W1	10-15	2	-	modern	modern
2	1982	2790	S2W1	30-40	2	hearth	100±60	1850±60
3	1983	2787	S2W1	30-40	2	-	105±70	1845±70
4	1984	2712	N2W2	10-20	2	-	modern	modern

*Dorsal and ventral sides.

could be the result of contamination through mixing of strata or exchange with younger organic matter. However, the range of variation of the radiocarbon dating method itself is also an important factor particularly in this case when the archaeological occupation may have occurred within the last 200 years within some sites.

Basaltic Glass Dating

In spite of a systematic examination of the screened sediment (using 1/8 inch screen) from archaeological sites, basaltic glass was recovered from only four (4) sites (9682, 2731, 2789 and 2787). The glass from Site 2789 (1 piece) and Site 2787 were undatable because they were opaque. The relative scarcity of this material in the archaeological deposits at Barbers Point is in marked contrast to those from other areas of O'ahu and other islands. This scarcity may be related to distance from the nearest source and the quantity of material available at the source. The specimens are small, almost all less than 1 centimeter at the long axis and have a high proportion of flakes to cores.

Twenty-one (21) specimens were thin sectioned by Dr. William K. Kikuchi of Crafts Hawaii with reference to the technique of Allman and Lawrence (1972) and Olsen (1980). The specimens were cut perpendicular to the long axis with a 4-inch copper rimmed diamond saw (0.014 inches) and mounted on glass slides with Lakeside 70 cement. The mounted specimens were ground to a thickness of approximately 4 microns with final grinding using number 1200 grade diamond abrasive. The ventral surfaces of each specimen were specially marked and used as the point of orientation in the final prepared slides.

Microscopic examination and rind measurement was accomplished by the Archaeological Research Center Hawaii, Inc., Geology-Hydration Rind Dating Department using a Nikon OPTIPHOT-POL, Polarizing Petrographic Microscope. All edges of each slide were scanned at 40 power and 100 power. The next step was scanning at 400 power for final selection of the most appropriate surfaces for measurement of rind thickness (except for slides of the opaque specimens). These surfaces were selected on the basis of the visual distinctness of the hydration/ alteration rind. These views were then photographed with a Nikon AFM Photo Micrographic attachments fitted with a Polaroid 545 Land Film holder using type 668 professional film. The measurements of rind thickness were made on the photographs themselves using a scale prepared from a similar photograph of a stage micrometer at the same magnification and setting as those of the specimen surfaces. The scale is divided into the equivalent of 1 micron units but estimates between these units could be made to an accuracy of .25 microns. Ten measurements were made from each photograph. The averages and standard deviations of these measurements are used for the calculation of basaltic glass years on the basis of a rate of 10 microns per 1000 years suggested by Olsen (1980). It is emphasized that the chronometric scale of measurement is in basaltic glass years and not actual calender years. The variability between these two scales is a problem which remains unresolved but will not be addressed here.

Rind measurements were taken on all surfaces on which a reading was possible (Table 7, Figure 88). Rind thicknessess and the calculation of age derived from them show a high degree of variation. The age determinations range from 9915 B.C. to 1760 A.D. Similar variation occurs in rind thicknessess from different surfaces of the same specimen. Comparing the age range of these samples and the presently accepted chronology of human occupation of the Hawaiian Islands (Morgenstein and Rosendahl 1976), it could be assumed that the older rinds developed on surfaces exposed through natural physical weathering of the specimen. Similarly, the younger rinds could have developed on surfaces exposed through deliberate human flaking or use. However, making the distinction on the basis of the accepted chronology alone is a circular argument and independent criteria are required. Two criteria become apparent immediately. The first is the flaking history of individual specimens based on the expectation that natural flaking would occur with considerably less frequency through time than would deliberate (or accidental) human flaking. The second is the morphology of the specimen - pattern and number of flake scars, striking platforms, and bulbs of percussion as the basis for distinguishing human flaking from natural physical weathering.

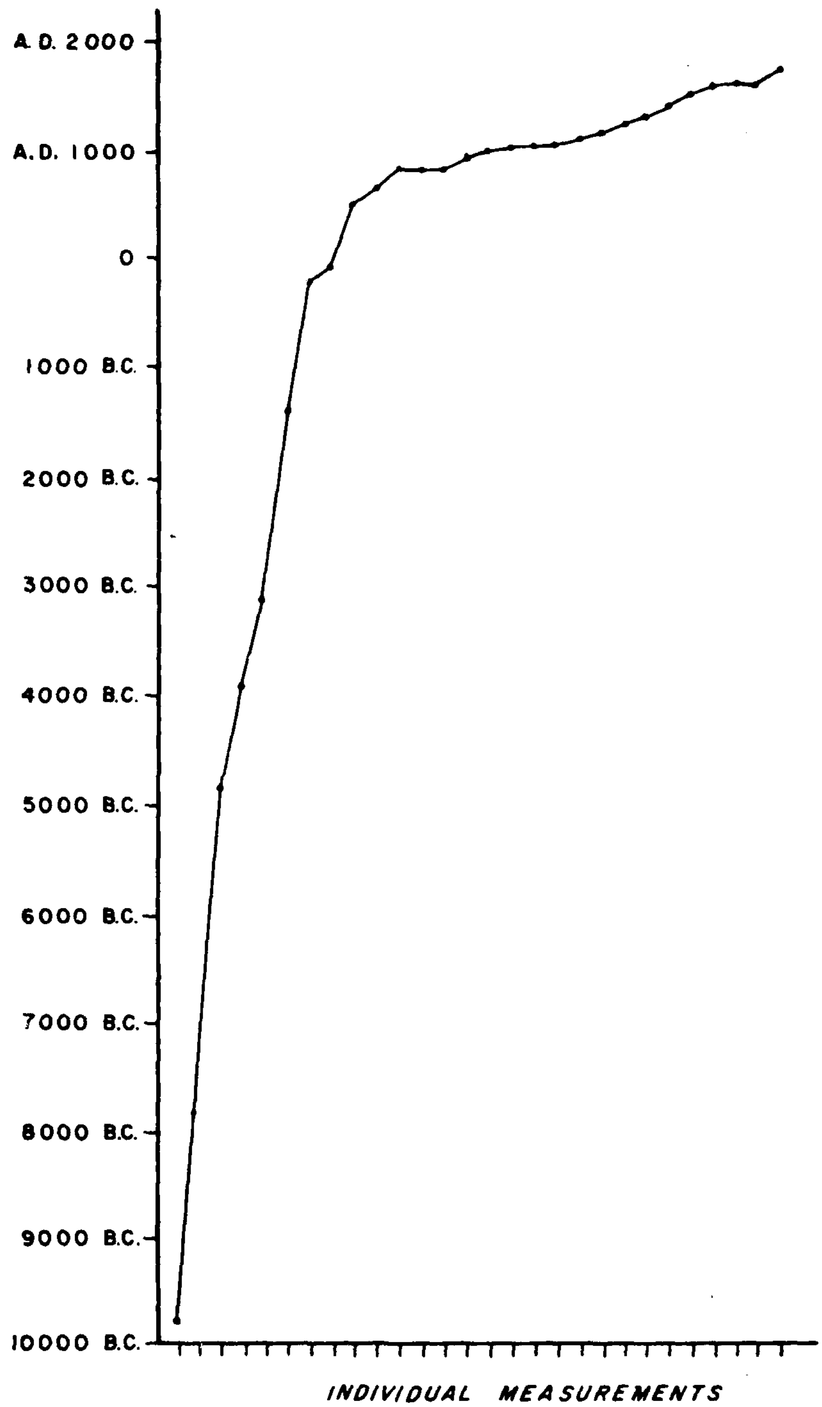


FIGURE 88 AGE ESTIMATES OF BASALTIC GLASS RIND MEASUREMENTS.

To address the first criterion, the dates from rind measurements of each specimen are plotted vertically to show its flaking history (Figure 89). Flaking occurred with greater frequency after 500 A.D. than before. The average interval between the breakage of a particular specimen before 500 A.D. is 3565 years, but after 500 A.D. this average interval is 259 years. Human flaking of the basaltic glass is the obvious explanation and it appears to have begun shortly after 500 A.D. Furthermore, even if all dates are rejected except for those derived from the last surface of each specimen, the span of human occupation would still be dated to 810 ± 111 basaltic glass years A.D.

In reference to the second criterion, the flaking patterns etc., all specimens were examined for special characteristics which would allow them to be distinguished as humanly flaked pieces. Of 11 specimens, 7 are flakes (273, 274, 285, 140, 393, 306, 89), three are cores (272, 294, 278) and one is an irregularly shaped nodule (271). The flakes which have been unmodified since their extraction from the cores could be the result of either natural or human flaking (specimen 306, 89). Others show flake scars on the dorsal surface which are almost certainly the result of patterned flaking by man. Specimen 140 is of particular interest. Its ventral side, dated to 680 ± 186 basaltic glass years A.D. contains a scar of a hinge fracture (Crabtree 1972). This type of fracture is rarely produced during physical weathering but is a common occurrence in archaeological contexts (Bense 1972). The dorsal side of this specimen, dated to 810 ± 111 basaltic glass years A.D. contains at least seven scars from the removal of thin pressure flakes which are certainly the result of human activity. The date of 550 ± 75 basaltic glass years A.D. was calculated from the ventral side of specimen 285 and cannot be distinguished as cultural or natural on the basis of lithic characteristics. If this date was rejected and only the dates on the human flakes surfaces accepted, the earliest date would still be 680 ± 186 basaltic glass years A.D. on specimen 140 and, therefore, the chronological range of human activity would not significantly change.

Ten (10) of the eleven (11) samples dated are from Site 9682 and one (1) sample is from Site 2731. Although basaltic glass (one specimen each) was recovered from two other archaeological sites (2789 and 2787)

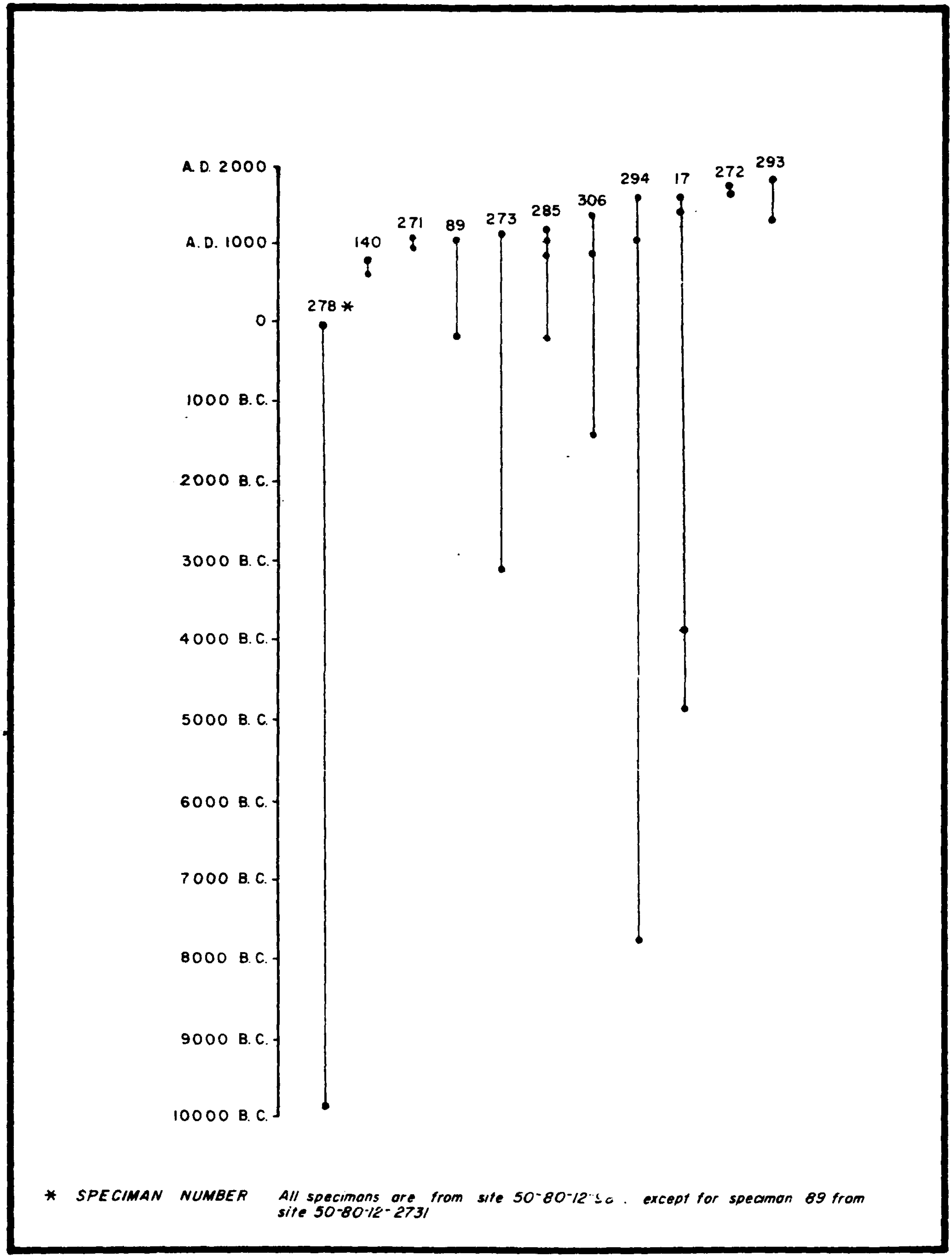


FIGURE 89 BASALTIC GLASS RIND AGE ESTIMATES BY SPECIMAN.

these were opaque and undatable. As a result, the basaltic glass chronology for the sites in the project area can be discussed only on the basis of two sites. Site 2731 is dated to 1080 ± 96 basaltic glass years A.D. Site 9682 shows human activity ranging from approximately 550 to approximately 1760 basaltic glass years A.D., a time span of 1200 basaltic glass years.

Is this site unique at Barber's Point or does its chronology range stand out only because of the lack of datable glass at other sites? The archaeological deposit is not substantially thicker or deeper than those of other sites nor is there any evidence to suggest repeated phases of rebuilding of the structure itself. However, the site is located along the rim of a small marsh; an ideal location for occupation particularly in early phases when bird hunting may have been the predominate mode of subsistence. All other basaltic glass dates from archaeological sites at the Barber's Point locality have been late prehistoric. Dates from Site B6-70 range from 1612 to 1650 basaltic glass years A.D. (Sinoto, 1978) and dates from adjacent Site B6-58 range from 1593 to 1801 basaltic glass years A.D. Two (2) other sites (B6-94 and B6-77) are dated to 1666-1743 and 1801 basaltic glass years respectively. Site 9682 is, so far, an anomaly compared to these dates, not only in terms of the earliest occupation but also the time span. In this context, the lack of glass from other sites is particularly unfortunate.

It is further observed that the dates from Site 9682 are not internally consistent within the stratigraphic context. The rind thicknesses do not show a pattern of greater age with increasing depth in the stratigraphic profile. This is probably a reflection of the mixing of deposits caused by kiawe roots and prehistoric cultural disturbance (a pit in Stratum II in S2W1).

Some general statements concerning the nature of the source of the Barber's Point basaltic glass are possible. It is suggested on the basis of the long time span represented between breakages of specimens (an average of 3565 years for the period before 500 A.D.) that the source is in an environment of relative geologic stability. A location subject to action of running water or the sea can be eliminated. More likely it is a stable well vegetated gently sloping terrain. The material from one possible source is probably characterized by a high titano magnetite content and is similar to material recovered previously by Morgenstein (in Sinoto 1978:62). The high titano magnetite content of many of the specimens rendered them opaque when thin sectioned and made measurement of the rinds impossible.

It would be highly desirable to expand the presently limited archaeological chronology at Barber's Point with other quantitative dates. Radiocarbon dating of marine shell material and bone from archaeological sites is a possibility. This would be especially relevant for Site 9682 for comparison to the basaltic glass chronology for that site. Samples from this site are being submitted to Beta Analytic, Inc. for dating. The results of this dating will be forwarded to the Corps of Engineers. Efforts to further define a chronology of human and paleontological events at Barber's Point are far from over. However, it is essential to carefully select materials and methods for dating in the perspective of the results presented above.

BARBER'S POINT PERSPECTIVE

The main thrust of this project was the excavation of archaeological sites within the area covering a portion of the proposed Barber's Point Deep Draft Harbor. The interpretation of the 25 sites excavated has had this emphasis:

1. The ordering of sites within a chronometric or relative time frame.

2. Inter-site comparisons on the basis of midden and artifact assemblages to document change in subsistence and domestic and possibly social groupings.

3. Documentation of spacial patterns within sites, particularly the patterns of food residue and artifact disposal and their relationships to size and configuration of the structures.

4. Determination of the nature and extent of environmental change concentrating on the agricultural potential, the vegetation reconstruction, and the human avifaunal relationships.

Each of these areas is discussed separately below.

CHRONOLOGY

Compared to other site areas on O'ahu and on other islands, basaltic glass occurs rarely as part of the artifact inventory. To our knowledge, four Barber's Point sites were dated by basaltic glass hydration methods in previous projects (Sinoto 1976 and 1978).

Twenty (20) dates for Site B6-58 range from 1593 A.D. to 1824 basaltic glass years A.D. Two (2) dates from B6-94 are 1666 and 1743 basaltic glass years A.D. (Sinoto 1976). In a 1977 Bishop Museum excavation project, Site B6-70 was dated 1612 to 1650 basaltic glass years A.D.

As part of this project, two (2) sites were dated by basaltic glass hydration methods. Site 2731 is dated to 1080 ± 96 basaltic glass years A.D. Basaltic glass from Site 9682 ranges from 550 ± 75 to 1760 ± 21 A.D. with a total of 19 rind measurements on nine (9) specimen dated between this range. The glass dates from both of these sites are considerably earlier than those from previously dated sites. Those from Site 9682 may indicate that Kalaeloa was one of the first to be visited after the arrival of the first Hawaiians. These dates rank in age with those from Bellows (Tuggle, Cordy and Child 1977) and Halawa (Kirch 1975), presently among the oldest dated archaeological sites in Hawai'i. The problem here is that at Site 9682 these early dates cannot be associated with a discreet intact cultural layer. There is no consistency of dates in terms of their stratigraphic context within the site because of mixing of deposits. In addition, the physical characteristics of the site shows no archaeological indication of 1200 years of human activity. This, compiled with the fact that the dates (in basaltic glass years) are believed to be reliable creates an anomalous situation. In this context it is particularly unfortunate that basaltic glass is a scarce material at Kalaeloa sites. The next step is the attempt at dating other organic materials in spite of problems of contamination and carbonate exchange, particularly in the "basic" environment of the area (Sheppard, J.C. 1975). These samples have been selected to complement results presently available.

Attempts at radiocarbon dating have not been satisfactory. Modern or submodern dates were given to the four (4) charcoal samples submitted--one each from Sites 2712, 2777, 2787, and 2795 as part of this project. All samples were from apparently undisturbed context and the charcoal itself was in excellent condition. Although mixing and modern burning must have caused contamination, these dates may well reflect the true ages of the charcoal samples. Unfortunately, most of these sites remain undatable by reliable and readily available methods, and a schematic chronological ordering of sites can be based only on nonquantitative criteria (for a more detailed discussion see Summary of Results).

SETTLEMENT PATTERNS

On the basis of available dates, exploitation of this raised reef area may have been early in the context of overall settlement of the Hawaiian Islands. This area could have been one of the earliest visited by Hawaiians as early as 550 basaltic glass years A.D. However, the pattern was of individual or small group intermittent occupation.

The majority of habitation features are small, simply built stone structures made of local limestone slabs and rubble. The cultural layers within them contain the remains of domestic and economic activities (almost entirely fishing-related) as well as marine and, to a small extent, terrestrial food remains. However, the layers are generally thin and closely clustered around the structures and adjacent sinks. The groups occupying some of these sites probably consisted of one (1) or two (2) individuals. Midden assemblages from some sites show heavy emphasis on a few species. Examples of these are the large quantity of pipipi (Nerita picea) at Site 9682 and Stephanolepis princei or S. spilosomus at Site 2777. These finds create a picture of seasonal or periodic occupation possibly coinciding with a period of agricultural inactivity, with heavy exploitation of marine species inhabiting the reef ecosystem.

The placement of sites in relation to one another shows either a general lack of spacial association. This is probably partly a result of modern disturbance. Sites 2712 and 2787 are the two exceptions (see Figure 3). The features of 2787 particularly suggest a small kauhale in its clustering of features. It should be kept in mind that extensive modern landscape modifidiations due to military use and kiawe cutting have probably destroyed many sites and left only remnants of the overall former prehistoric landscape.

Sinoto (1976), as a result of his excavations, considers "the types and nature of the sites", i.e., well built structures and substantial amounts of midden and debitage from tool manufacturing activities. On this basis he suggests that "at one time the whole 'Ewa plain was one continuous complex of similar sites" and "that the area was used for more than temporary or transient occupation", (Sinoto

1976:70-71). In 1977 a simple test was conducted to determine time and effort required to construct a site typical of the Kalaeloa area (see last page of this section). The results of archaeological excavations of Site 50-10-5-8001 at 'Ouli, Hawai'i (Hammatt and Folk 1980) showed intermittent occupation, abandonment and reoccupation producing significantly large assemblages of artifacts and midden. In this perspective the probability of extensive site contemporaneity at Kalaeloa can be questioned.

Sinoto (1976:71), in treating the historic materials found at Barber's Point, presents two (2) hypotheses concerning the period of occupation. These are: 1) the sites "may have been abandoned and then modified and utilized in historic times", or 2) "constructed during proto-historic times and continuously occupied into historic times". Sinoto favors the second hypothesis based on "the presence of one cultural component and no hiatus". Results of the archaeological excavations conducted during the present study indicate that Sinoto's first hypothesis is more probable because the presence of two (2) cultural components has now been documented for Kalaeloa sites; the A1 horizon containing evidence of modern occupation and use by <u>nā paniolo</u>, the military and <u>kiawe</u> loggers, and the A3 horizon containing evidence of traditional Hawaiian occupation only. The lack of evidence for a time lapse in occupation in the A3 horizon can be explained by the compressed and mixed state of that stratigraphic unit. This is in contrast to areas such as South Point, and Kawaihae where the extensive and deep deposits of pahala ash are constantly bei· reworked into and over the cultural remains. The cultural deposits at Kalaeloa have been deflated and reworked by a number of physical and biological processes including subsequent cultural activity. Further-more, on the basis of available quantitative dating int· ite contemporaneity is unlikely. This supports Sinoto's statement that "the present density of sites may well be the resulting expression of chronologically separate occupation" (Sinoto 1976:71).

Using the archaeological survey data Davis (1978:196, Table 14) attempts to distinguish functional classes of sites based on area size. He then uses these classes as the basis to argue that "the settlement at Barber's Point was one of functionally integrated, multi-household residence groups". This argument assumes that the sites used in the tabulation are contemporaneous (Davis 1978:200). This assumption is also the basis for suggesting again, because of size, that "the settlement was minimally one of long-term, recurrent occupation of the same habitation areas". There are two (2) problems with this argument in view of the excavation results (herein). First, proof of contemporaneity is lacking in the archaeological data, in fact, the available data suggests a diachronic spread of up to 1200 years of use of the area resulting in the variety and distribution of sites now present. Secondly, the excavations reveal that two (2) sites (2723 and 2778) in Davis' class I are habitation sites, and that although Davis (1978:201) considers his class II and class III structures to be ordinary dwellings, Site 2712 and Site 2710-2 possess characteristics indicating that they may have functioned as hale mua or kauhale, contrary to the criteria used by Davis (1978:201). Other sites appearing as class II and III sites in Davis' Table 14 have proven to be non-occupation sites. Thus, determining site function at Kalaeloa on the basis of size alone is not possible. This should provide some perspective for Cordy's (1975) work at Kuapa Kaloko, Hawai'i and Kirch's (1971) at Palauea, Maui.

Davis (1978:200) also argues that "the local subsistence pattern focused on exploiting marine resources with the support of limited but labor intensive horticulture involving tree crops and/or root crops". The archaeology confirms the first part of this statement but has not provided evidence of labor intensive horticulture, although some horticulture is indicated by the large quantities of Assiminea nitida (refer to Appendix II) found in Site 2725.

ENVIRONMENTAL CHANGE AND PALEONTOLOGY

The past environment and the documentation of changes which occurred both before and after the human presence present a problem addressed in two special studies that are an integral part of this project. These were avian paleontological studies and landsnails analysis.

Avian Paleontological Studies

The avian paleontological studies conducted by Dr. Storrs Olson and Miss Helen James of the Smithsonian Institution included testing of a number of limestone sinks and major excavation in one, Sink 2624. This sink, over 3 meters deep and 4 meters long, is actually a complex of smaller sinks expanded by solution to one larger one with a number of small side chambers. The bulk of the paleontological excavations took place here because of the mass of bird bone and the unusual number of species, initially identified in the field. Although no evidence of cultural material was present, in all, almost 40 species of extinct birds were identified; eight (8) of them had not been identified on the Island of O'ahu before (see Appendix I). The varieties include seabirds, as well as small and large (some flightless) landbirds, some of them forest dwellers.

These fossil bone assemblages appear to occur in the larger (and older) sinks and are unassociated with cultural material. The fossil bones occur in distinct bone layers 10 to 20 centimeters thick, not more than 20 centimeters from the modern ground surface of the sink. They are found in loose, gravelly silt loam sediments. The coarse fraction is derived from the sink walls and the fine fraction is generally aeolian material reworked into the sinks by rainwater.

None of the fossil assemblages are associated with cultural material, except at Site 2763. The fine-textured sediments on the floor of this sink contained a rich cultural midden of dark-rumped petrel (*Pterodroma phaeopygia*) bones, associated with marine shell, charcoal, and a grinding stone. The bones are disarticulated and many are unbroken and unburned. The birds were probably steamed or boiled inside the sink. Extinct forest birds were recovered from this site but occurred stratigraphically below the single cultural layer. To date, seabirds (dark-rumped petrel or *Pterodroma phaeopygia*) and possibly other shearwater and petrel (*Procellariidae*) make up the only group found in direct association with archaeological layers. The dark-rumped petrel occurs most commonly in archaeological sites and was clearly the most heavily exploited species.

The forest birds and flightless species were not found in archaeological deposits. However, they still might be contemporaneous with the early human presence on O'ahu and (although less likely) with the later human presence at Barber's Point since only contemporaneously exploited food species of birds would be expected to occur in archaeological sites.

Chronometric dating of the sink deposits containing fossil bone assemblages is lacking. However, there is some paleontological evidence that the fossil assemblages of Barber's Point are younger than those on other islands. Specifically, rat and lizard bones (both introduced vertebrates) occur at Site 2624 in the same levels as the fossil bird assemblages. However, this occurrence in itself does not demonstrate contemporaneity with the fossil bird bones. Considering the strong possibility of mixing of deposits, only quantitative dating of the bones could demonstrate with any confidence contemporaniety with humanly introduced species and, therefore, with the presence of early Polynesians.

Because the sorting and analysis of bird bone has not been completed, conclusive statements cannot yet be made. Critical information is missing in two areas: (1) chronometric dating of bones; and (2) vertical distribution and association of bones of distinct species. The former information is necessary to establish their chronological relationship to human presence and probable cause of extinction; the latter to establish possible phases of extinction and species involved in each phase. With the information presently available and considering the number of species involved and the apparent suddenness of the extinction, at least on a geologic scale, it is difficult to avoid considering indirect human interference (habitat destruction) and possibly direct interference with selected food species as a major factor.

Landsnail Analysis

The landsnail analysis conducted by Dr. Patrick Kirch and Dr.

Carl Christensen of the Bishop Museum involved collection and analysis of samples from five (5) separate sites (see Appendix II). Two (2) of these sites (2712 and 2723) are habitation sites. One (2725) is a small shallow sink and two (B6-78 and 2624) are larger sinks with avifaunal assemblages but no cultural material. In each case, samples were taken at 5 to 10 centimeters intervals down trench profiles. Snails were separated, identified, and counted. Percentage figures were calculated for each sampling unit.

Except at Site 2725, a general trend is evident: (1) a decrease of most native extinct genuses, including Orobophana, Leptachatina, Cookeconcha and Endodonta; and (2) a simultaneous percentage increase in native extant varieties such as Lamellidea, Tornatellides, Lyropupa and Succinea. All these varieties are adapted to disturbed natural conditions. (3) Perhaps most important are the occurrence of two (2) taxa, Lamellaxis and Gastrocopta. Lamellaxis is believed to be an early Polynesian introduction and Gastrocopta, a modern introduction.

The translation of the absolute numbers of certain varieties of shells in each sample to percentage diagrams (Figures 92, 94, 96, 97, in Appendix II) must be qualified considering statistical constraints. This means that a percentage change may or may not be a reflection of the same direction of change in absolute numbers. For example, at paleontological Site 2624, between sample 1 and sample 2, the percentage of Lamellaxis increases from 3.7 percent to 4 percent, whereas the actual number decreases from 59 to 15. Between the same two samples, Gastrocopta increases from 4.3 percent to 12.3 percent, but the actual number decreases from 69 to 46.

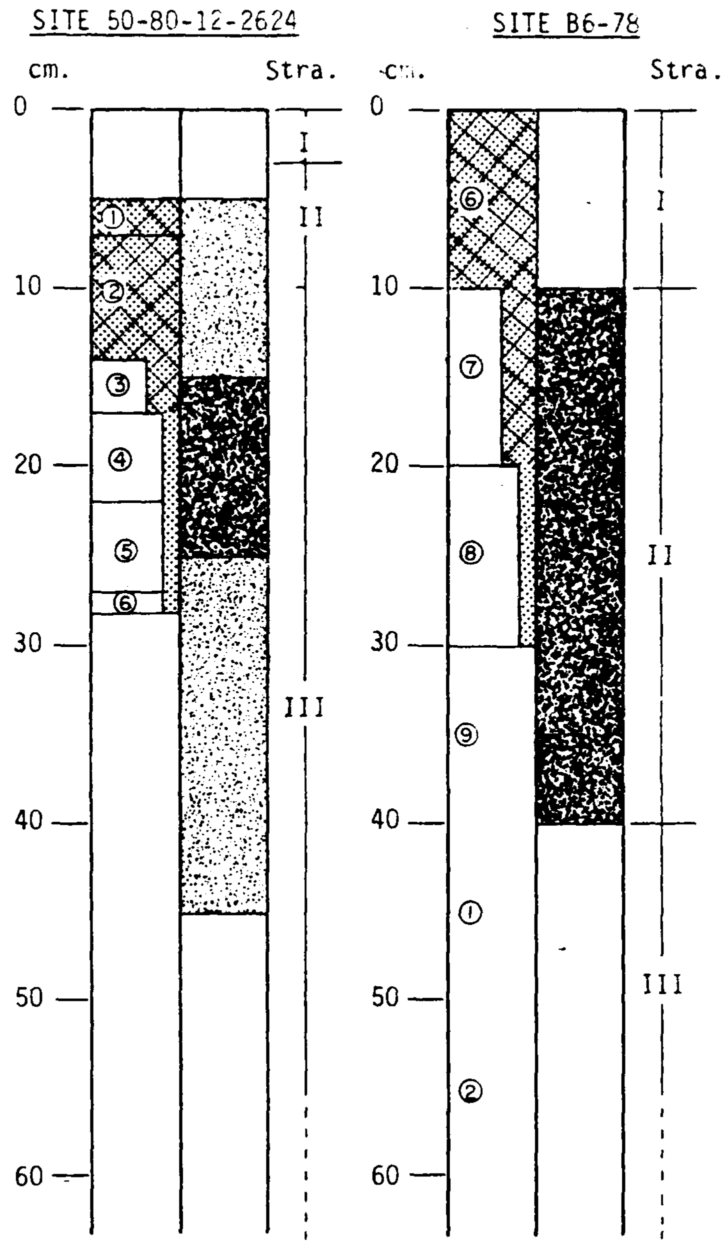
With these qualifications in mind, it is possible to suggest that changing landsnail assemblages reflect a fairly dry grassland, open parkland environment with possible decreased available moisture caused by decreased vegetation cover, probably through direct or indirect human intervention.

The outcome of competition between native and introduced species is also important in explaining changing fossil assemblages. For this reason, reconstruction of changing vegetation through changing fossil assemblages must be firmly based on the ecology of the species themselves.

Thorough examination of distribution of the occurrence of species Lamellaxis within the profiles of the sampled sites should be a means to mark the presence of early Polynesians. Likewise, the historically introduced snails Gastrocopta and Pseudopeas should mark the period of European contact. In the two paleontological sites sampled (B6-78 and 2624) Lamellaxis occurs stratigraphically below the historically introduced varieties, but only in small numbers--generally three or four per sampling unit. Likewise, the modern introduction (Gastrocopta) occurs in the prehistoric archaeological layer at Site 2712, although, again, in small numbers. Stratigraphic mixing caused by bioturbation on sedimentary processes may account for this. For this reason, distinguishing pre-Polynesian, prehistoric Polynesian, and Historic (post-European contact) periods remains difficult on the basis of only one criterion--presence or absence of these marker species.

Figure 90 shows the stratigraphic relationship of fossil bird assemblages to the Polynesian and European-introduced shell species within the two paleontological sites. The stratigraphic occurrence of the Polynesian-introduced snail Lamellaxis (as well as the historically introduced Gastrocopta) overlaps with the occurrence of fossil bird bones. Within the area of overlap, however, only a few specimens of the introduced species are represented or only small numbers of bird bones are present. In addition significant numbers of introduced snail species do not occur within the zone of major bird bone accumulation. The overlap may be explained in terms of mixing of deposits and may not indicate contemporaneity. Such mixing would involve both natural and biological processes. Of particular relevance is slumping of deposits in a limestone solution cavity environment. The effects of such sink action have been documented in limestone cave deposits in Indonesia in a similar bedrock environment to that at Kalaeloa (Glover 1979).

However, a fairly uniform rate of sedimentation within sink deposits is probable and geologic unconformities within such a depositional environment are unlikely. Therefore, with or without the actual overlap, a close geological succession is indicated. At present,



KEY:

Polynesian Introduced Landsnails

Modern Introduced Landsnails

Lesser Occurence Of Extinct Bird Bones

Main Occurence Of Extinct Bird Bones

NOTE: All encircled numbers indicate Kirch and Christensen shell sample units.

FIGURE 90 PALEONTOLOGICAL SINKS 50-80-12-2624, AND B6-78. STRATIGRAPHIC COMPARISON OF MARKER SPECIES OF LANDSNAILS AND FOSSIL BIRD BONE LAYERS.

it appears that extinction of at least a portion of the Barber's Point avifauna occurred late in geologic time and is closely associated stratigraphically with both the Polynesian and historically introduced shells. Further, stratigraphic separation of bird bone assemblages and chronometric dating can provide a basis for more precise definition of this association.

Using information available now, human and environmental succession at Barber's Point is summarized as follows:

1. The prehistoric environment of Barber's Point consisted of fairly arid parkland which was the habitat for endemic species of forest birds and the nesting place for flightless birds and seabirds. This probably facilitated early exploitation of the naturally occuring food resources in contrast to more densely vegetated areas where the local avifauna must also have been plentiful.

2. The presence of Polynesians and the accompanying environmental change probably make up the major factor in the extinction of many of the avifaunal species. In the case of forest birds, extinction probably was caused by habitat destruction, particulary by reduction of tree cover. In the case of seabirds (petrel and shearwater) population reduction might have been related to their use as a food resource. Archaeological evidence of this was found at Site 2763 and to a lesser degree at the other habitation sites. The exploitation of seabirds as a food resource might have provided the initial attraction for prehistoric Polynesians to this karstic plain from the very earliest period of Hawaiian settlement of the Islands.

3. On available dating evidence, this area--excluding the coastline--was first exploited early in Hawaiian prehistory. Small shelters were constructed and probably in later times improved upon with adjacent sinks used as planting areas. Evidence exists that the deposits in these sinks were enriched

for agricultural production by adding muck, probably from an adjacent marshy pond. Although the organic matter has dissipated, the landsnails (Assiminea) transported with the muck remain within the sink deposits.

4. The karst landscape never supported a large human population and habitation was mainly oriented to periodic exploitation of marine and terrestrial resources available. Even the larger structural foundations represent only a few hours of stacking the locally ubiquitous limestone. In a replicative experiment in 1977, a well-built average size "U-shaped" structure was constructed by three people in 55 minutes. Cultural layers associated with these structures are thin and the artifact assemblages within them contain a high proportion of fishing gear. Exploitation of terrestrial resources, except seabirds, was ancillary to fishing and is confined to the larger sites. The development of occupation and exploitative patterns at Barber's Point do not represent a unique adaptation to a unique environment. Rather, they represent a response to the potential of this area in the context of the resource capabilities of the entire ahupua'a of which it is only a part. The people who exploited this karstic region also had culturally dictated acess to the rich terrestrial and marine resources of Honouliuli which in later times included lo'i and fishponds. The people who exploited this region and made their temporary dwelling here did so in accordance with an adoptive strategy which took into account a wide range of resouces. The settlement at Barber's Point is a reflection of the manner in which one portion of these resources were managed and cannot be the sole basis of determining the lifestyle or status of the inhabitants. In this context the characterization of Barber's Point as a "marginal" area begs the question - in relation to what?

APPENDICIES

APPENDIX I

PALEONTOLOGICAL SALVAGE AT BARBER'S POINT, O'AHU

by

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prepared for

ARCHAEOLOGICAL RESEARCH CENTER HAWAII, INC.

Division of Birds
National Museum of Natural History
Smithsonian Institution
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We are grateful to Francis K.W. Ching and Hallett H. Hammatt of the Archaeological Research Center Hawaii, Inc. (ARCH) for including paleontological salvage in their research plans for Barber's Point, and for their competent coordination of our activities while in Hawaii. The ARCH field crew at Barber's Point carried out the paleontological salvage with admirable energy and efficiency, and included Hallett H. Hammatt, William Folk, Virgil Meeker, and Douglas Borthwick.

C. John and Carol Pearson Ralph graciously provided accommodations for us in their home, as they have on many other occasions.

At the Bernice P. Bishop Museum, Alan Ziegler allowed us to commandeer much of his office and laboratory space for the preparation of specimens and concentrate for shipping, and loaned us packing materials, camping gear, and other equipment. Aki Sinoto and Eric Komori took time from their work to conduct further testing of site 50-0a-B6-22, a promising paleontological site which is not in the territory covered by the ARCH salvage project.

We also thank David Brown for patiently picking small bones from the concentrate at the National Museum of Natural History.

APPENDIX I (continued): Paleontological Salvage at Barber's Point, Oahu

INTRODUCTION

The discovery of rich deposits of fossil birds at Barber's Point, O'ahu, has greatly enhanced our more comprehensive project of analyzing the fossil and evolutionary history of the Hawaiian avifauna. Both the Bishop Museum and the National Museum of Natural History (Smithsonian Institution) now possess large collections of fossil birds from the main Hawaiian Islands, the reward of ten years collecting. In addition to the material thus far recovered from sinkholes at Barber's Point, we have also had the benefit of many fossil specimens from sites in the ancient dunes of Moloka'i (near Mo'omomi Beach and 'Ilio Point) and Kaua'i (Makaweli Dunes near Po'ipu), and to a lesser extent from lava tubes on Maui and Hawai'i.

Although in terms of absolute numbers, most of the bones are the fossil and subfossil remains of seabirds, the more fascinating discoveries are of a great variety of extinct native land birds. Three fossil species have been described in the scientific literature; Geochen rhuax, a goose from the Island of Hawai'i (Wetmore 1943), Thambetochen chauliodous, a larger flightless goose from Moloka'i, and Apteribis glenos, a bizarre flightless ibis from Moloka'i (Olson and Wetmore, 1976). When the remaining extinct fossil birds now in museum collections are described, the known avifauna of Hawaii, present and past, will be nearly doubled. We can state without hesitation that the fossil record that is coming to light in Hawaii is unparalleled anywhere in the world for documenting the evolutionary and faunal changes in the avifauna of an isolated archipelago. The scientific value of these collections can hardly be overestimated. They offer diverse opportunities for study of evolution and adaptation, and also provide a historical context for testing current theories of dispersal, faunal turnover, and speciation in island biotas.

The tremendous number of avian extinctions documented by the fossil record greatly exceeds what would be expected from natural causes. Extinctions occurred not only in all of the large flightless birds, which would have been easy prey items for the Polynesian colonists, but also in birds of prey and numerous small forest birds. The evidence strongly suggests that habitat destruction by Polynesians, particularly of the drier lowland forests, was severe enough to cause widespread extinction in the avifauna of the archipelago, and very probably in other segments of the biota as well.

The fossil deposits at Barber's Point are of special importance in this respect, as they provide the first good opportunity for proving the hypothesized contemporaneity of Polynesian culture and an extinct avifauna. Direct proof of this hypothesis would have broad implications for both archaeological and biological research. For archaeologists, it would greatly improve our concept of the original Hawaiian environment at the time of prehistoric colonization and suggest new directions of research in the increasingly important field of prehistoric man's impact on island ecosystems. For biologists, it would shed doubt on the common assumption of island biogeographers that the historic biota of a given island represents its naturally occurring complement of species.

With a view towards enlarging our sample of fossil birds from Barber's Point and of searching for proof of Polynesian contemporaneity, the authors participated in the 1980 salvage project by Archaeological Research Center Hawaii, Inc. The paleontological salvage took place between March 31 and April 3, 1980. This report constitutes a preliminary analysis of the vertebrate remains that were recovered.

METHODS

Previous excavations at Barber's Point have shown that sinkholes with large enough openings for easy access, deep lying soil floors, and thick deposits of soil, are most productive paleontologically (Sinoto 1978). Further, some sinks that meet these conditions are poor in fossils because the soil layer lies too near the water table for good bone preservation.

We tested as many sinks that met these criteria as time permitted. Where possible, we excavated square meter pits, but boulders and vegetation often frustrated this plan. Sediment was removed in levels approximately 10 centimeters in depth, then screened through 1/4-inch mesh screens and 1/8-inch mesh screens successively. As the dark humus overburden or A horizon does not bear fossil birds, this sediment was often discarded without screening. All bird bones and midden encountered in the screens were saved.

Paleontological material collected at Barber's Point before the 1980 excavations is biased toward well-preserved, large bones. Since many species of native forest birds have very small, fragile bones, easily confused with bits of irregularly shaped limestone, we determined to correct this sampling bias by saving the concentrate in the 1/8-inch mesh screens for picking in the laboratory. If a particular sinkhole was poor in bird bones only a few screen loads of concentrate were saved from each level.

At the Bishop Museum, the bones were rough-sorted and packed for shipment to the National Museum of Natural History (NMNH). The concentrate was wet-screened and dried to reduce its weight.

The final curation and analysis of the paleontological material from Barber's Point is still in progress at the NMNH. All of the concentrate has now been picked for small bones, which have in turn been rough-sorted. Final identification of fossils has begun, but this is a time-consuming task that will not be completed in the near future.

RESULTS

Fossil and subfossil bones were recovered from six (6) sinkhoes, as follows:

50-80-12-2622
2762
2763
9656
2623
2624

LESSER SITES

The first five (5) sites listed are of "lesser" paleontological value only in comparison to 2624, the largest of the sinks excavated. No final identifications have been made for these five sinks. The most common bird recovered is Pterodroma phaeopygia (dark-rumped petrel). Bones of extinct land birds were recorded from all of the sinks except 2763, and the concentrate from these sinks was surprisingly rich in small bones.

Site 2763 was clearly an archaeological accumulation and contained a rich midden of Pterodroma phaeopygia bones, occasional pipipi shells, and a grinding stone. The petrel bones appear not to have been broken during cooking, suggesting that the birds were prepared steamed or boiled whole.

SITE 2624

Site 2624 was a paleontological mecca. All areas with productive deposits in this sink were salvaged by excavating six irregularly shaped pits (Figures 91 and 92). Since the final analysis of these deposits will have to await identification and dating of the paleontological material (now in progress), only preliminary observations can be offered at this time.

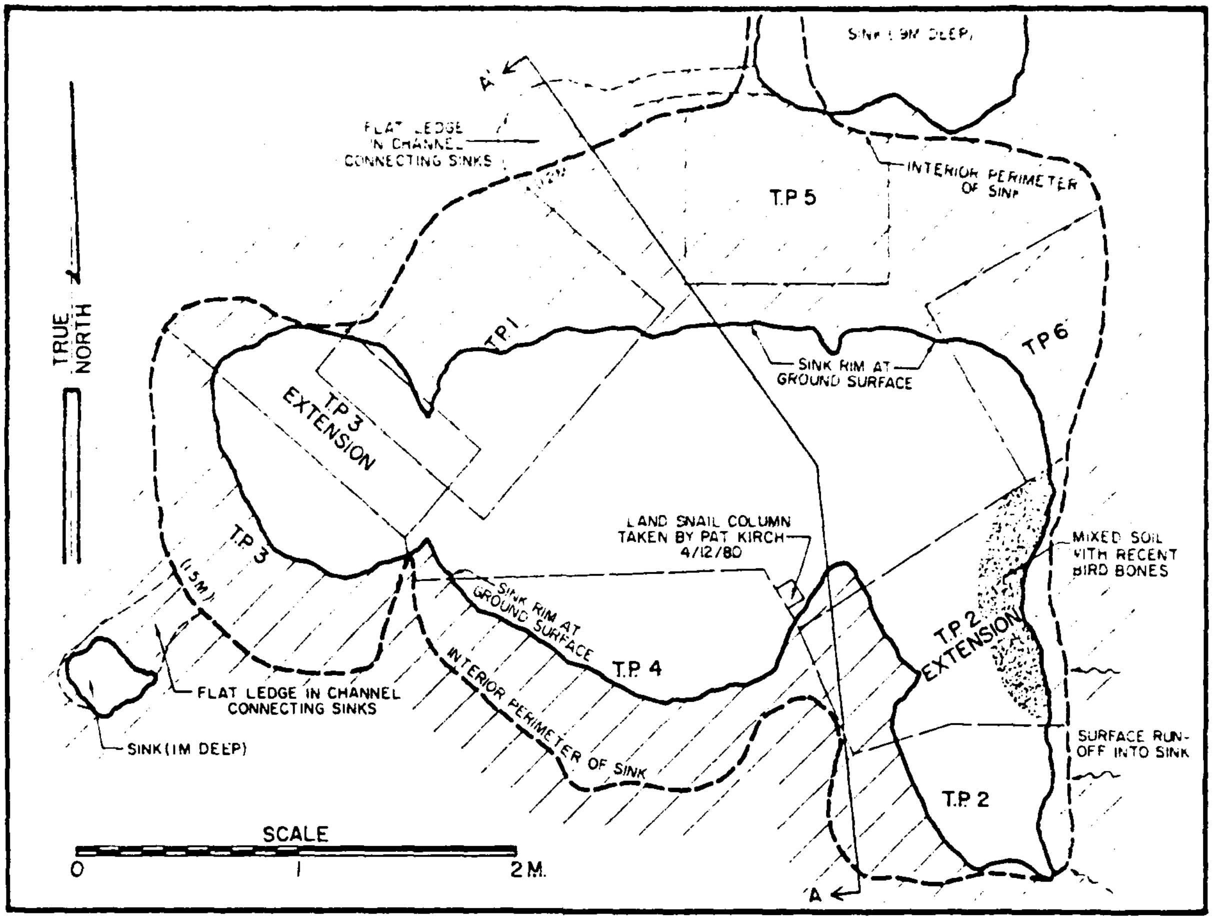

FIGURE 91 PLAN VIEW OF SITE 50-80-12-2624, SHOWING EXCAVATION TRENCHES

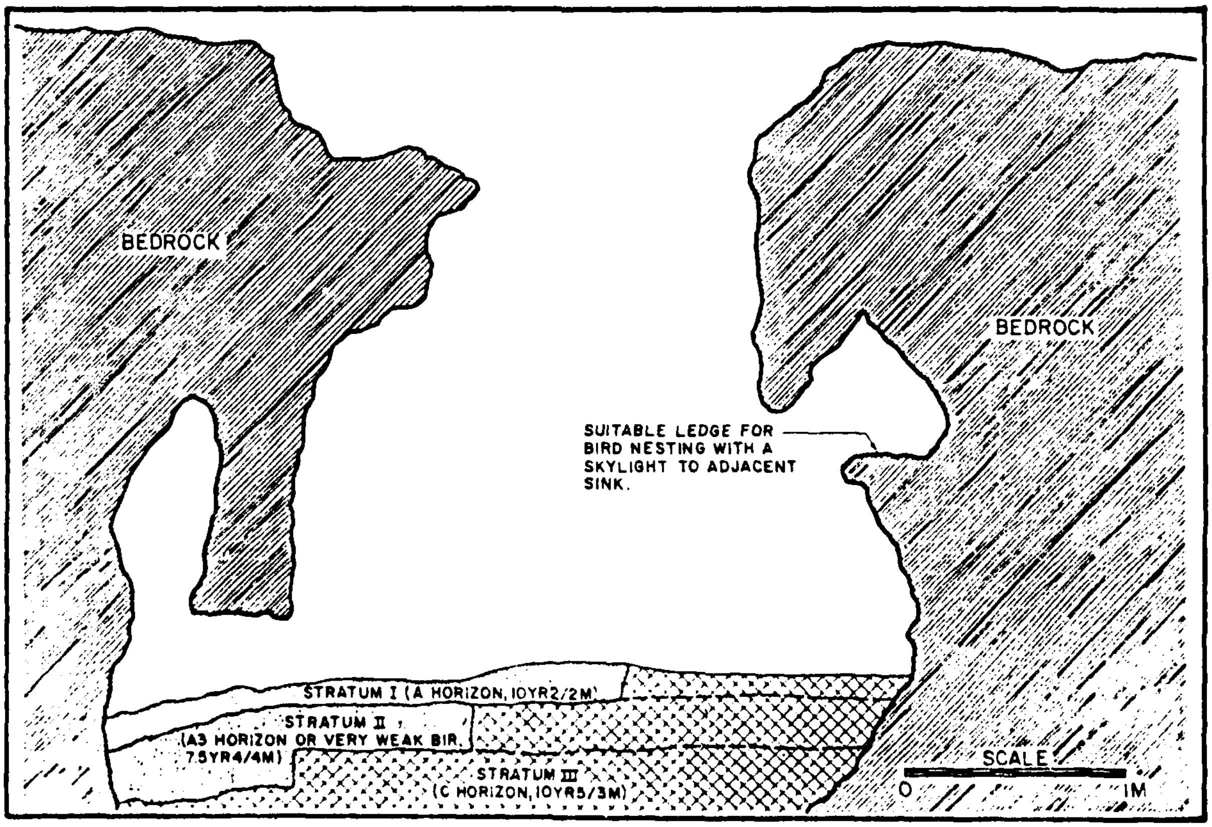

FIGURE 92 CROSS SECTION A-A' OF SITE 50-80-12-2624.

Vertebrate Fauna

The bird bones recovered from 2624 include a phenomenal variety of species. Nearly all land birds known previously as fossils from Barber's Point are present, as well as at least eight (8) species not heretofore identified in a fossil context on O'ahu. Six (6) of the newly found species belong in the endemic Hawaiian family of small forest birds, the Drepanididae. The other two (2), coot and gallinule, are waterbirds. In addition to the new species, invaluable specimens were collected of several extinct species for which we had scant material before.

The multitude of small birdbones recovered both from onsite screening and from picking concentrate in the laboratory may provide the first sound basis for faunal comparisions between Barber's Point and the owl pellet deposits from Moloka'i and Kaua'i.

Of mammals, the site produced a few bat bones and a great many rodent bones. The common rodent is tentatively identified as Rattus exulans (introduced by the Polynesians); the bat as Lasiurus cinereus semotus (the only native Hawaiian bat).

An unexpected bonus of picking concentrate in the laboratory was the recovery of many tiny bones of lizards. Two (2) species are present, a gecko and a skink (Gregory Pregill, personal communication). Both are probably tramp species believed to have become established after 1778. Their presence in the Barber's Point deposits will either indicate them to have arrived with the Polynesians, or indicate mixing of sediments (see below). It is likely that the lizards inhabit leaf litter at Barber's Point today.

Stratigraphic Distribution of Vertebrates

In most pits, the level 10 to 20 centimeters below the A horizon was richest in bird fossils, although bones were found above this level and as far below as 30 to 40 centimeters, the deepest extent of our excavations (Pits 2 and 3). The most productive deposits were along the south and west walls of the sink (Pits 2, 3, and 4), Pits 1, 5, and 6 being somewhat poorer in fossils.

Rodent and lizard bones are not distributed in the same way as birds. These taxa are most common in the 0 to 10 centimeter level (below A horizon), slightly less common in the 10 to 20 centimeter level and increasingly uncommon in the lower levels, although both do occur in all levels excavated.

The results of a terrestrial landsnail analysis of a stratigraphic column taken from the face of Pit 4 (Figure 91) indicate that soil mixing has not been severe at this site (Kirch and Christensen 1980, Appendix II in this report). However, we did find some evidence of mixing during excavation. In Pit 2 extension, near the wall of the sinkhole, a pocket of darker soil extending into the level 0 to 10 centimeters below the A horizon contained much of the associated skeletons of a large rat and a myna (Acridotheres tristis), both historical introductions. Rain-water runoff into the sink may account for the deposition of this very recent pocket of soil (Figure 91).

Other possible sources of soil mixing include root growth and burrowing by rodents and petrels. Both the Polynesian rat and the dark-rumped petrel are known to burrow in some situations, but they may not have done so at Barber's Point where the karst topography provides ample protection. Determining the extent of soil mixing will have to be done before the significance of rat and lizard bones in the same strata as extinct birds can be interpreted.

PRELIMINARY ANNOTATED LIST OF FOSSIL BIRDS FROM BARBER'S POINT

The authors are currently preparing a more definitive synopsis of fossil birds from the Hawaiian islands. The present list represents our preliminary identifications for the purposes of this report and should not be cited or circulated beyond its intended audience without permission. Although we intend to suggest changes in the classification of various Hawaiian birds, we have followed the currently accepted nomenclature here. Undescribed taxa are given very informal, descriptive English names. A question mark before a name indicates that identification is tentative.

PROCELLARIIFORMES

None of the procellariiform birds from Barber's Point occur on O'ahu today, with the exception of Puffinus pacificus.

Procellariidae

Pterodroma phaeopygia (dark-rumped petrel or 'Ua 'u) the most common fossil from Barber's Point.

Pterodroma hypoleuca (Bonin petrel)

?Bulweria bulwerii (Bulwers petrel or 'ou)

Small petrel, species undet.; either a new species of extinct petrel or a known petrel whose range no longer includes the Hawaiian Chain.

Puffinus pacificus (Wedge-tailed shearwater or 'ua 'u kani)

Puffinus puffinus (Newell's shearwater or 'a 'o)

Puffinus lherminieri (Audubon's shearwater)

Oceanitidae

Oceanodroma castro (Harcourt's storm-petrel)

ANSERIFORMES

Anatidae

Branta sp. An apparently new species of flying goose, probably related to *Branta sandvicensis* (nene) which is extant on Hawai'i and formerly occurred on Maui, where it has been reintroduced.

Thambetochen sp. A new species of large flightless goose that is congeneric with the fossil goose of Moloka'i, *Thambetochen chauliodous* , yet distinct from it in many characters.

Anas sp. Possibly *Anas wyviliana* (Hawaiian duck or koloa) which formerly occurred on O'ahu and has been reintroduced.

FALCONIFORMES

Accipitridae

Haliaeetus sp. Preliminary comparisons of the few eagle bones from Barber's Point, and also from Moloka'i, indicate that the Hawaiian islands once had an endemic species of eagle.

Hawk. This is probably *Buteo solitarius*, an endemic Hawaiian hawk which is known as a living species only from the Big Island.

GRUIFORMES

Rallidae

Small flightless rail — Medium-sized flightless rail: Flightless rails existed on the Islands of Hawai'i and Laysan in historic times and are rumored to have existed on other Hawaiian islands, but all are extinct today. None were previously known from O'ahu.

Gallinula chloropus A Hawaiian subspecies of gallinule is extant on O'ahu.

Fulica [illegible] The Hawaiian subspecies of coot is extant on O'ahu.

CHARADRIIFORMES

Charadriidae

Pluvialis dominica The American Golden Plover is a common winter migrant on O'ahu.

Scolopacidae

Numenius tahitiensis The bristle-thighed curlew occurs on O'ahu today as a rare winter migrant.

STRIGIFORMES

Strigidae

Asio flammeus The Hawaiian subspecies of short-eared owl is extant on O'ahu.

Long-legged owl. A new genus of endemic Hawaiian owl known only from fossils. Three species have been found, one each from O'ahu, Kaua'i, and Moloka'i. This owl may be responsible for depositing most of the remains of small forest birds found as fossils.

PASSERIFORMES

Corvidae

Two (2) new species of crows. The two (2) fossil crows are similar in size, and about one-third again the size of the Hawaiian crow or 'alala (*Corvus tropicus*), which is endemic to the Island of Hawai'i. One species may be related to *Corvus tropicus*, but the other is very distinct.

Turdidae

Phaeornis sp. Probably *Phaeornis obscurus oahuensis* ('amaui), which survived on O'ahu to historic times but is now extinct. No specimens exist, other than the fossils.

Muscicapidae

Chasiempis sp. Probably *Chasiempis sandwichensis*, ('elepaio), which is still fairly common in the mountains of O'ahu today.

Meliphagidae

Chaetoptila sp. An endemic genus previously known from a few skins taken on the Island of Hawai'i, where it has long been extinct. Whether the O'ahu form is conspecific with *Chaetoptila augustipluma* of Hawai'i or represents a new species is not yet known.

Moho sp. Four species of this second endemic Hawaiian genus of Meliphagidae survived to historic times, one each on Hawai'i, Moloka'i, O'ahu, and Kaua'i. All are now extinct except the Kaua'i species, which is extremely rare and endangered. The fossils from Barber's Point are probably conspecific with *M. apicalis*, the O'ahu *'o'o*.

Drepanididae

The *Drepanididae* or Hawaiian honeycreepers are considered to be a distinct passerine family endemic to the Hawaiian Archipelago. The 23 species known historically, and the many new fossil forms, evolved from a single ancestral species of finch that colonized the archipelago and underwent a spectacular adaptive radiation. The diversity of drepanidid species far exceeds that of the famous Galapagos finches, or of any other island radiation of small forest birds.

Good fossil deposits of drepanidids containing many extinct species have been found on Moloka'i and Kaua'i, but the collections from O'ahu are by far the richest. Sixteen species have been recovered from Barber's Point to date, including 10 that became extinct prehistorically.

Efforts to retrieve the small bones of these birds during the 1980 excavations were extremely successful, adding no less than five species to the list of fossil drepanidids from Barber's Point.

Leeward Island finch. Possibly a new species. Similar species are known from Laysan and Nihoa.

Psittirostra bailleui. Previously known as an extant species from the island of Hawai'i only.

Psittirostra psittacea. Formerly known as an extant species on nearly all of the main islands, including O'ahu, where it is now extinct.

Ridg[illegible] finch. New species. Fossils of this species occur on Moloka'i also.

Giant Kona finch. New species; O'ahu only.

Smaller Kona finch. New species; O'ahu only.

Wierd new O'ahu finch. Affinities uncertain.

Hemignathus lucidus. Known from O'ahu historically.

New *Hemignathus*-like bird. New species; also known from Kaua'i fossils.

New gaping bird. New genus and species; genus also known from Moloka'i fossils.

New sickle-billed bird. New species, O'ahu only.

Loxops maculata. Extant on O'ahu.

Loxops virens. Extant on O'ahu.

Ciridops sp. New species; genus known historically from Hawai'i only.

Himatione sanguinea. Extant on O'ahu.

Vestiaria coccinea. Extant or very recently extirpated on O'ahu.

DISCUSSION

AGE OF THE DEPOSITS

Due to the nature of deposition at Barber's Point, we cannot assume that the fossils represent a coetaneous fauna. Soil deposition in the sinks begins soon after their formation, and sinks have been forming in the fossil reef contniuously since its emergence. Additional research is required to establish the absolute age of fossils, the length of deposition in each significant sink, and the relative ages of deposits from different sinks, before faunal comparisons with other islands can be reliably made.

Certain faunal elements from Site 2624 and some other sinks suggest that the Barber's Point fossils are younger than the deposits from other Hawaiian islands. These include the introduced rodent and lizards, and several species of birds that we believe evolved very recently. The mere presence of introduced vertebrates in the same layer as extinct birds is not adequate proof of recency (see page 215). However, if relative dating techniques such as amino acid racemization show rat and extinct bird bones from the same stratum to be the same age, this would demonstrate that Polynesian man and the extinct avifauna coexisted for a time on O'ahu. In the absence of absolute radiometric dates, the presence of dated rodent remains could also provide a frame of reference for distinguishing older and younger deposits.

EXTINCTIONS IN THE AVIFAUNA OF O'AHU

It need hardly be pointed out that none of the fossil land birds from Barber's Point occur there today. Only six of the 30 fossil land birds are still extant on O'ahu, and all but one of these (*Asio flammeus*) are restricted to the relatively undisturbed wet forests of the Ko'olau and Wai'anae ranges. In the modern history of the main Hawaiian islands, O'ahu was the first to suffer major declines in its native avifauna (Atkinson 1977), and today, half of the 12 native land birds known as living species on O'ahu are believed to be extinct (Table 8).

Comparing the unhappy fate of O'ahu's historic avifauna to the fossil record of prehistoric extinctions (Table 8), we find that the great decline began prior to 1778. Two-thirds of the thirty fossil land birds vanished before the arrival of modern skin collectors. At present, the only plausible explanation for this phenomenal number of extinctions is that O'ahu experienced severe habitat destruction before 1778, and that more recent perturbations have merely accelerated the trend.

TABLE 8

TABULAR SUMMARY OF EXTINCTIONS
IN THE NATIVE LAND BIRDS OF O'AHU

	Historic		Fossil	
	Number of Species	Number of Modern Extinctions	Number of Species	Number of Prehistoric Extinctions
Nonpasserine	1	0	8	7
Passerine	11	6	22	13
All land birds	12	6	30	20

RECOMMENDATIONS

FUTURE LABORATORY WORK

The identification and analysis of fossil bird collections from Barber's Point will be carried out at the NMNH as part of the author's research on the Hawaiian avifauna. We intend to publish a preliminary paper summarizing current knowledge of fossil birds from Hawaii, followed by a series of monographs treating the major taxonomic groups.

The greatest remaining laboratory research problem is aging the deposits, which is essential to any adequate interpretation of the fossils. Since our attempts to date the dune deposits of Mo!oka'i and Kaua'i by the radiocarbon age of landsnail shells have not been successful, relative dating techniques may have to suffice. We hope to make arrangements through NMNH for this work.

FUTURE EXCAVATIONS

All large, deep sinks slated for destruction should be salvaged. The Barber's Point area is the only place on O'ahu where fossil birds have been found, and it is very likely that no similar deposits exist elsewhere on the island.

A number of outstanding research problems can only be solved by additional excavations. Too many of the fossil species are represented in collections by only one or a few scraps of bone. Unless more complete specimens are collected, any reconstructions or systematic comparisons of these species will be largely conjectural. Considering the number of new species recovered from Site 2624, the remaining deposits also have a good potential for producing more species.

The taphonomy of the Barber's Point deposits is poorly understood at present. Some of the sinkholes undoubtedly acted as natural traps, particularly for flightless birds. The sinkholes may have provided nesting sites for seabirds, which could account for the plentitude of petrel bones. But how the remainder of the fossils were deposited is obscure. One possible explanation for the deposition of small passerine bones is that the extinct owl roosted in larger sinks, leaving regugitated pellets. However, the distribution and concentration of smaller bird bones is not what one expects of owl pellet deposits. Future excavations should be designed to solve these problems.

Although the findings of Kirch and Christensen (see Appendix II) are a good beginning for reconstructing the paleo-environment at Barber's Point; further efforts in this direction are also recommended.

SUMMARY

1. Excavations of limestone sinkholes at Barber's Point, O'ahu, have revealed the bones of a phenomenal variety of extinct birds, ranging from a large flightless goose and an eagle to many small forest birds.

2. Predation and habitat desctruction by Polynesians are the most likely causes of the prehistoric extinction of many of the fossil birds.

3. Good fossil deposits have been found on other Hawaiian islands as well, but the Barber's Point deposits are particularly important because: (a) they are richest in species, and (b) they may provide the only opportunity for demonstrating Polynesian contemporaneity with an extinct avifauna.

4. As part of the 1980 slavage work of the Archaeological Research Center Hawaii, Inc., six sinks were excavated for paleontological remains. A great number of fossil bird bones were recovered, including eight species not previously recorded as fossils from Barber's Point. Other vertebrate remains included rodent, bat, skink, and gecko.

5. Further excavations and laboratory work must be completed before the Barber's Point paleontological deposits can be adequately analyzed.

APPENDIX II
NONMARINE MOLLUSCS AND PALEOECOLOGY AT BARBER'S POINT, O'AHU

by

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Carl C. Christensen, PhD.

prepared for

ARCHAEOLOGICAL RESEARCH CENTER HAWAII, INC.

Department of Anthropology
Bernice P. Bishop Museum

July 1980

ACKNOWLEDGEMENTS

We wish to aknowledge Dr. Yoshio Kondo for graciously permitting us access to the collections and laboratory facilities of the Division of Malacology, B.P. Bishop Museum. Our ultimate debt is to Dr. C. Montague Cooke, Jr., who over a half century amassed the collections upon which all work in Hawaiian malacology must be based.

APPENDIX II (continued): Nonmarine Molluscs and Paleoecology at Barber's Point, O'ahu

INTRODUCTION

In 1976, the Bishop Museum conducted an archaeological survey and test excavations at Barber's Point (Sinoto 1976), revealing the presence of fossil bones of endemic birds in limestone sink deposits. A number of extinct species unknown to science were represented. During a subsequent salvage phase of archaeological investigation (Sinoto 1978), one of the authors of this appendix (P. V. Kirch) became aware that these paleontological deposits contained, in addition to avian remains, an abundance of fossil and subfossil shells of terrestrial snails. A preliminary study (Kirch 1978) was made of these snails from one of the salvaged sites (OA-B6-78), from excavated soil samples (unfortunately, without the benefit of field, quantitative sampling). The results indicated some potential for the interpretation of paleo-environmental change. This is of obvious relevance to the question of avifaunal extinction. For these reasons, further quantitative work was recommended.

In April 1980, we were requested by Dr. H. Hammatt of Archaeological Research Center Hawaii, Inc., to conduct further investigations of landsnails in archaeological and paleontological sites to be excavated under his direction. In cooperation with the ARCH field team, we obtained column samples from two limestone sinks containing fossil birdbone (2624, 2763), two habitation sites (2712, 2723), and one small, culturally sterile, sink. In addition, we sampled the deep sink (B6-78) previously excavated by Sinoto (1978). This report presents the results of our analyses for all sites sampled except one sink (Site 2763). The samples from this site will be processed at a future date.

Although terrestrial snails have been used extensively by archaeologists and paleontologists in the reconstruction of ancient environments in England and the continental United States (Evans 1972, Kerney 1966, Cheatum and Allen 1964), the technique is still embryonic in Hawaii. The authors have been collaborating on the analysis of landsnails from archaeological sites in Hawai'i and other Pacific islands (Kirch 1975, Kirch and Christensen 1979, Christensen and Kirch in press), and results to date are extremely promising. Nevertheless, we stress that we are still in the experimental stage in developing analytical and interpretive procedures (the present project being, in fact, the first such analysis to receive funding as part of a "contract archaeology" program). Therefore we have chosen to err, as it were, on the side of caution. As a result of this project, however, we are even more firmly than ever convinced that paleo-malacological studies can be a significant source of information on prehistoric Hawaiian environments, including the often-salient effects of man's actions.

MATERIAL AND METHODS

The principles underlying paleo-malacological analysis are rather simple and parallel those of palynology. Landsnails are, firstly, ubiquitous in most ecological communities, and given proper conditions for their preservation (usually a calcareous edaphic environment), are also abundant in many ancient sediments. Secondly, snails are especially sensitive to local environmental conditions, particularly vegetation and its effect upon moisture (Peake 1978). In the Hawaiian Islands, terrestrial gastropods--along with the vascular plants, insects, and birds--underwent extensive adaptive radiation, resulting in the evolution of more than 1,200 endemic species (in 12 families) from perhaps 25 ancestral immigrant stocks (Zimmerman 1948). Many of these species have rather restricted ranges and are sensitive to change in ecological conditions. Unfortunately, we cannot claim a complete understanding of the taxonomy of Hawaiian snails let alone of their ecology. Many species are as yet undescribed, and revisions of major groups are necessary. These deficiencies at times hamper the effectiveness of paleo-ecological interpretations based on landsnail evidence.

Paleo-malacological analysis is based upon the assumption that the specific composition of a fossil landsnail assemblage should reflect local ecological conditions at the time of death and burial of the snails, just as in pollen analysis it is assumed that the frequencies of pollen grains in a particular deposit reflect the vegetation from which they were derived. This underlying assumption may potentially be qualified by a number of variables. These include taphonomic factors of burial and preservation of the fossil assemblage (e.g., the potential mixing of deposits by bioturbation, etc.), and the adequacy of sampling. Given careful consideration of these potential error factors, snail analysis can provide accurate information on past environments and has been shown to accord closely with results obtained through pollen analysis (Evans 1972). The details of our field and laboratory procedures are outlined below and are diagrammed in Figure 93.

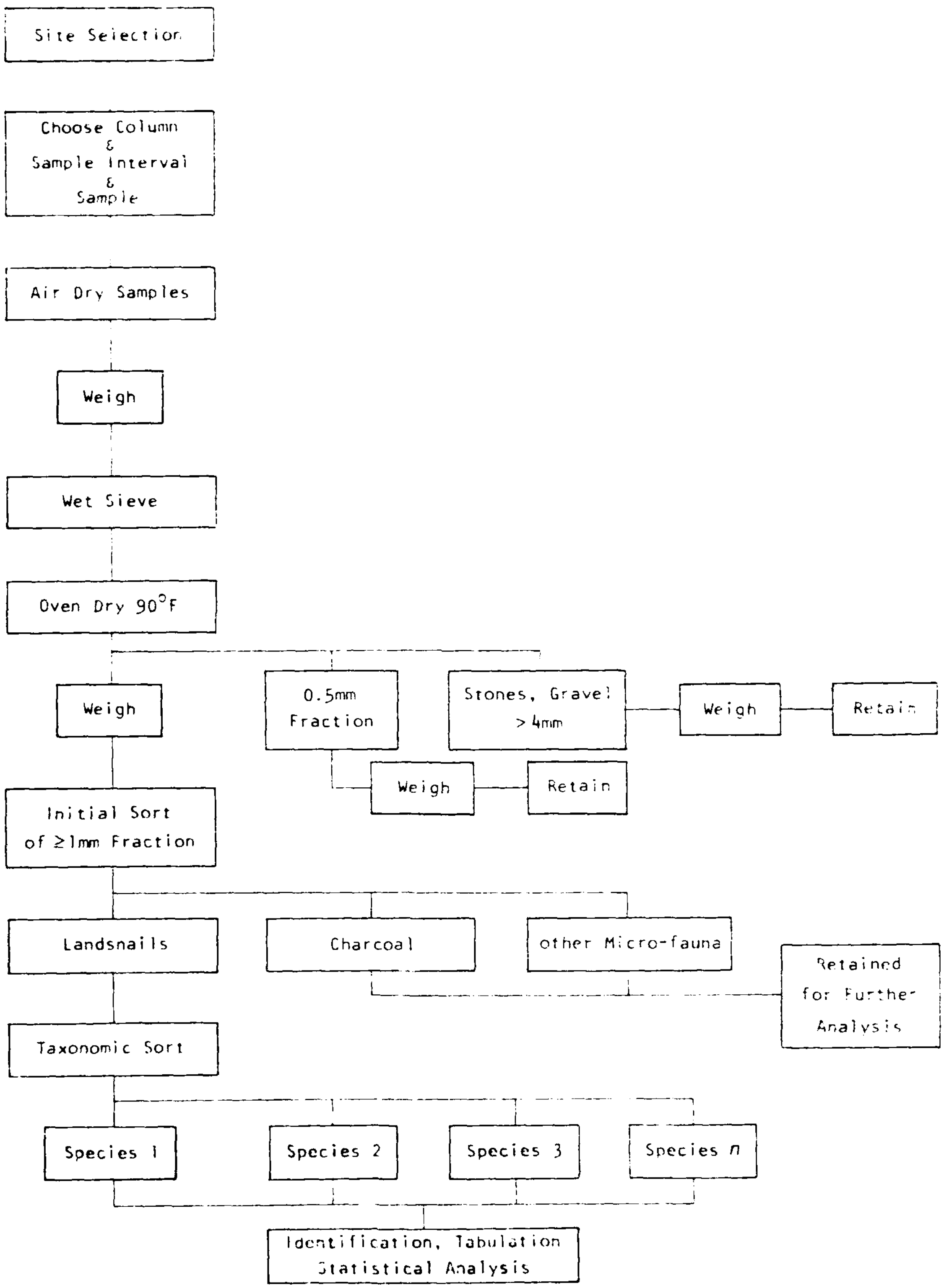

FIGURE 93 FLOW CHART ILLUSTRATING FIELD AND LABORATORY PROCEDURES USED IN BARBER'S POINT LANDSNAIL ANALYSIS.

SAMPLING

Soil samples for fossil snail extraction were taken as continuous columns (5 or 10 centimeters^2 in area) cut into exposed vertical stratigraphic sections. Columns were taken at a point where the stratigraphic section was relatively complete and apparently free of disturbance. Sampling intervals ranged from 2 to 10 centimeters in depth, but did not cross stratigraphic boundaries. At the time that samples were collected, notes were also made on the stratigraphic profile. We did not conduct a detailed stratigraphic analysis, since this was to be accomplished by the ARCH team.

EXTRACTION

In the laboratory, each sample was air-dried and weighed on an Ohaus triple-beam balance. The sample was then wet-sieved through a series of 4-millimeter, 1-millimeter, and 0.5-millimeter meshes (the less than 0.5-millimeter fraction was not retained). These fractions were oven-dried (90° F) for 24 hours, weighed, and bagged separately.

The 4-millimeter and 1-millimeter fractions were hand-sorted under a low-power (ca. 7X) microscope, and all countable snails (those including the apex) and fragments of species not represented by countable apices, as well as bones, charcoal, marine shells, etc., were removed. In one case (the topmost sample of Site B6-78) snails were so numerous that only a portion of the 1-millimeter fraction was sorted. A correction factor was introduced on the basis of sorted portion/total weight. In all other instances, the entire 4-millimeter and 1-millimeter fractions were sorted for snails. Although workers in other regions routinely separate snails retained by the 0.5-millimeter mesh, the presence of heavy calcareous deposits on shells in some deeper levels made recognition of heavily encrusted shells impossible. In the interest of consistency, 0.5-millimeter fractions were therefore not considered in this analysis.

COUNTING AND IDENTIFICATION

During the project a total of 21,270 snails were counted and identified. To prevent counting broken shells twice, only intact shells and fragments containing the shell apex were counted. An exception was made for subfossil snail eggs. Since *Lamellaxis gracilis* is the only oviparous species present at Barber's Point and since embryonic shells recognizable as belonging to the family Subulinidae were found in most of those eggs opened, each egg was counted as one individual of *L. gracilis*. Identifiable, non-apical fragments of species not otherwise represented in a sample are indicated in the data tables with a plus sign (+). Living snails (principally *Gastrocopta*) found in archaeological samples were not counted. Their presence resulted from contamination. This is certainly true with *Gastrocopta* in Site B6-78 as excavation had been left open for two years and the snails must have been sealed to the sides of the trench.

Given the large number of endemic Hawaiian species of terrestrial snails, it was imperative that identifications be based not only on published keys and descriptions but on the basis of one-to-one comparisons with reference material. We were fortunate in having access to the extensive collections of the Division of Malacology, B. P. Bishop Museum. In most cases identification to the species level was possible. Where the broken or immature condition of the specimens or the unsettled taxonomy of the group (as in the case of *Tornatellides*) prevented precise identification, determination at the family or generic level was made. In a few cases shells were so poorly preserved that no identification was possible. It should be noted that two of the species reported here are as yet undescribed in the malacological literature. We intend to publish descriptions of these new species at a later date.

STATISTICAL AND GRAPHICAL ANALYSIS

Raw counts of snails for each sample are presented in Tables 10, 12, and 14 through 16. Since sample size varied it is not possible to base inter-sample comparisons and interpretations on such raw scores. We have adjusted the original counts by converting them to percentage scores. Alternatively, the data could be standardized by conversion to concentration indices (e.g., snails/100 g. of sediment); we have calculated such indices only for the total number of snails per sample.

In the present analysis we have not attempted to estimate statistical error or confidence intervals for the reported frequencies. For those interested in calculating confidence intervals on our data, the multinomial distribution formulae of Mosimann (1965) for pollen data are applicable.

The results of these analyses can most readily be understood visually, and graphic summaries of each stratigraphic column are presented in Figures 94, 96, 98, and 99. In interpreting the stratigraphic columns of the two deeper sinks (B6-78 and 2624), we have made use of paleoecological similarity matrices. As discussed by Pielou (1979), such matrices are useful in determining the degree of grading, or of discontinuity, in a stratigraphic sequence. The similarity matrix itself is calculated using Whittaker's (1952) Proportonal Similarity Index,

where T_1 is the quantity of all snail species in sample 1, and x_{j1} is the quantity of species j in sample 1. The extent to which the matrix is graded is determined by the use of the Q/Q_{max} ratio, as described by Pielou (1979).

ECOLOGICAL INTERPRETATIONS

Ecological data pertinent to the various species were abstracted from published sources, when available, or from data associated with specimens in the collection of the Bishop Museum. Because of time constraints, no extensive search of the latter material was possible, and conclusions should be regarded as preliminary. Detailed data on association of particular snail species with host plant species is available for European and the continental American snail species. These data are not available for Hawaiian snails. Therefore, it was decided to divide the snails into the following groups: (1) Native, extinct (NE)--- species locally extinct in the Barber's Point study area but living elsewhere as well as universally extinct taxa; (2) Native, extant (NL)—still inhabiting the study area; (3) Introduced (I)--including prehistoric and historic introductions; and (4) Freshwater (FW)---snails dwelling in fresh or brackish water.

In order to determine the nature of the modern litter fauna a sample of leaf litter was taken from the vicinity of B6-78. All live snails (as evidenced by mucus seals, visible animal, etc.) were sorted out by hand and counted. Dead snails were ignored so as not to allow contamination by subfossil shells mixed in the soil. Results are presented in Table 9. Living species not inhabiting litter are under-represented by this count. *Succinea caduca* and *Tornatellides* are certainly more common in the area than indicated by the litter sample (*Succinea* is found sealed under rocks, and *Tornatellides* may be arboreal).

TABLE 9

COMPOSITION OF MODERN LITTER FAUNA

Taxon	Count	Percentage
Lamellidea gracilis	146	29.3
Tornatellides sp.	18	3.6
Lyropupa perlonga	16	3.2
Gastrocopta servilis	318	63.7
Succinea caduca	1	0.2

SYSTEMATIC REVIEW

The Barber's Point snails were sorted into 19 taxonomic categories (not including unidentified specimens) probably representing between 21 and 25 species. These categories are reviewed below in systematic order, including available data on ecological range.

FAMILY HELICINIDAE

Orobophana uberta (Gould, 1847)

According to Neal (1934), this species occurs on O'ahu, where it has been found to occur over a wide altitudinal range. She reports that these snails live on the gound on dead leaves and twigs. Little is known of their vegetational preferences, although at one location the species was collected among *kukui* (*Aleurites*) trees. *Orobophana uberta* was formerly more widely distributed than today. Fossil or subfossil shells may be found in abundance at Barber's Point, and other localities where the species is now extinct.

FAMILY ASSIMENEIDAE

Assiminea nitida (Pease, 1865)

Assiminea nitida is an amphibious snail of wide distribution among the islands of the Indo-Pacific region. Kay (1979) reports Hawaiian representatives of the species under rubble along the shoreline. Snails of this genus are usually associated with brackish water (Abbott 1958) as at Kualoa, O'ahu, Christensen (unpublished observations) found *A. nitida* to live in moderate abundance under rocks at the edge of a brackish pond.

FAMILY ACHATINELLIDAE

Lamellidea spp.

Lamellidea gracilis (Pease, 1871) was represented in all samples examined. No other species of Lamellidea were identified with assurance in this material, but the immature or fragmentary nature of many of the specimens necessitates use of the less precise identification "Lamellidea spp." in the statistical analyses. L. gracilis occurs throughout the Hawaiian Islands at elevations of less than 1,000 feet (Cooke & Kondo 1960). It is one of the few native species able to survive in areas of exotic vegetation and is a common component of the modern leaf litter fauna in the Barber's Point study area.

Tornatellides spp.

At least three species of Tornatellides are represented in the Barber's Point material. Possibly the most abundant of these is T. macromphala (Ancey, 1903), a species occurring on several of the main islands in the Hawaiian chain and apparently the only member of the genus now inhabiting the study area. Because of the difficulty of identifying immature or broken shells of this genus, no attempt has been made to differentiate the various species present in these samples. For purposes of ecological analysis all Tornatellides found are classified as "native extant" taxa, even though only one species is known to inhabit the Barber's Point region at present. We do not believe that this unavoidable oversimplification causes the importance of the "native extant" faunal element to be significantly overstated in any sample. Little is known of the ecological preferences of these species, although the persistence of T. macromphala in a region of exotic vegetation is indicative of its broad tolerance of changing ecological conditions.

FAMILY AMASTRIDAE

Leptachatina (Angulidens) cookei Pilsbry, 1914

Fossil or subfossil shells of this species have been found in a few scattered locations in the arid coastal regions below the Wai'anae Mountains in western O'ahu. L. cookei is now extinct. Angulidens, the subgenus to which both of the Leptachatina in the Barber's Point deposits belong, is represented by one or more species on each of the main islands of the Hawaiian chain. Nearly all of these are extinct taxa formerly inhabiting lowland areas (Pilsbry and Cooke 1915-1916).

Some specimens of Leptachatina, are too immature or fragmentary for precise identification. They are either L. cookei or L. subcylindracea and are listed in the data tables as "Leptachatina sp.".

Leptachatina (Angulidens) subcylindracea Cooke, 1911

Like the preceding species, Leptachatina subcylindracea is an extinct lowland snail. It was formerly widely distributed on O'ahu and has also been reported from Moloka'i and Kaho'olawe.

Amastridae (Unidentified)

Some apical fragments or very immature shells of amastrid snails cannot be assigned with certainty to any particular genus. Some may be of the species of Leptachatina represented in these deposits. Others may be of a species of Amastra not otherwise found in our material. A few specimens of Amastra (Cyclamastra) umbilicata (Pfeiffer 1855) were recovered from soil excavated by ARCH from Site 2624, but the species was not identified in our samples from this or other sites.

FAMILY VERTIGINIDAE

Lyropupa (Mirapupa) perlonga (Pease, 1871)

This species occurs abundantly in the fossil and subfossil deposits of coastal O'ahu. A subspecies is found on Ni'ihau and Kaua'i. Species of the subgenus Mirapupa are restricted to arid low-elevation sites (Pilsbry and Cooke 1918-20). Living individuals of Lyropupa perlonga are rarely encountered. The only live-collected Bishop Museum lot for which data on plant associations are available is BPBM 21939, containing numerous specimens found on pili grass (Heteropogon) at Koko Head, O'ahu, in 1911. Small numbers of L. perlonga were found living in leaf litter taken in the immediate vicinity of Site B6-78, a region of kiawe forest. The species is thus one of the few native snails tolerant of such disturbed conditions.

Nesopupa litoralis Cooke and Pilsbry, 1920

This extinct species is known only from fossil or subfossil shells found in a few scattered localities on the O'ahu coastal plain (Pilsbry and Cooke, 1918-1920).

Nesopupa newcombi (Pfeiffer, 1852)

This species has been reported from most of the main Hawaiian islands. It is often found in lowland deposits, but also occurs in inland locations. Its ecology is otherwise unknown. No living or freshly-dead shells of Nesopupa newcombi were found during the present study, and the species is apparently extinct in the Barber's Point region.

FAMILY CHONDRINIDAE

Gastrocopta servilis (Gould, 1943)

This Neotropical species has been transported throughout the islands of the Pacific by modern commerce. It has been present in Hawai'i at least since 1892 (Ancey 1892), when specimens mistakenly believed to be indigenous to these islands were described as *Pupa lyonsiana* Ancey. *Gastrocopta servilis* is now the most abundant snail in the leaf litter fauna of the Barber's Point study area.

FAMILY PUPILLIDAE

Pupoidopsis hawaiiensis Pilsbry and Cooke, 1921

Fossil and subfossil shells of *Pupoidopsis hawaiiensis* are often abundant in aeolian sandstones and other deposits in the coastal lowlands of the main Hawaiian islands. However, the species is thought to be extinct throughout the state. On Christmas Island, the only other location in which the species is known to occur, living snails have been found on the bunchgrass *Lepturus*, a habitat probably similar to that formerly occupied by *Pupoidopsis* in Hawai'i (Cooke and Neal 1928).

FAMILY SUCCINEIDAE

Succinea spp.

The great majority of the succineids recovered from excavations in the Barber's Point area appear to be referable to *Succinea caduca* Mighels, 1845. This is a native species found throughout the main islands of Hawaii in coastal, often arid, locations. The species currently inhabits the study area, where estivating individuals can often be found in abundance sealed to the undersides of limestone blocks. The subfossil material examined exhibits a considerable range of shell forms.

The Barber's Point succineids are here cited as "Succinea spp.", an imprecise determination necessitated by the confused taxonomic state of Hawaiian Succineidae. It is difficult to make identifications in this group based solely upon shell characters.

FAMILY ENDODONTIDAE

Cookeconcha n. sp.

These specimens are of an undescribed species of Cookeconcha, now extinct, that formerly inhabited the arid lowlands of the 'Ewa Plain.

Pilsbry and Vanatta (1906) stated that species of Cookeconcha "live on dead stumps and logs, and under the bark of dead trees, but also under fallen leaves." Solem (1976) added that these snails "have also been found in heavy moss on large boulders and at low levels on tree trunks." These remarks are probably more relevant to species of the mountain forests than to those of dryer low-elevation sites such as the current study area. Most of the lowland species had become extinct prior to the activities of modern malacologists. Undescribed species of Cookeconcha were observed living in pili grass (Heteropogon) at Koko Head, O'ahu (BPBM 21938, collected 1911) and on the bunchgrass Eragrostis on the island of Nihoa (BPBM 54514 et seq., collected 1923). These records may indicate the preferred habitat of the Barber's Point species. It should be noted that Lyropupa perlonga, a species common in the Barber's Point samples, was found living in the company of the Cookeconcha species at the Koko Head location.

Endodonta n. sp.

The second endodontid snail present in the Barber's Point material is also an extinct species restricted to the Barber's Point-'Ewa Plain region. As with Cookeconcha, published ecological data are most pertinent to species from high-elevation or other moist environments. An exception is the report by Cooke (1928) of the occurrence of living Endodonta "in talus slopes of the Wai'anae Mountains, some of them in dry and exposed situations." An undescribed Endodonta was found living in company with Cookeconcha in bunchgrass on Nihoa (BPBM 57361 et seq., collected 1923). The Barber's Point species may have occurred under similar conditions.

FAMILY SUBULINIDAE

Lamellaxis gracilis (Hutton, 1834)

This adventive species, of uncertain geographical origins, is known to have become established in several island groups in Oceania prior to the advent of European influence in the Pacific (Christensen and Kirch in press). Although no records of the occurrence of this species in Hawaiian archaeological sites of prehistoric age are known to us, we anticipate that Lamellaxis gracilis will be demonstrated to have reached these islands prior to A.D. 1778. In none of the sites examined here do the adventive snails introduced during the modern period (Gastrocopta servilis or Pseudopeas tuckeri) occur in stratigraphic levels below the earliest occurrence of L. gracilis.

A number of subfossil snail eggs of the type produced by L. gracilis were found. Several of these were opened, and contained embryonic shells of a subulinid species. As the only other subulinid found in the Barber's Point material (Pseudopeas tuckeri) is ovoviviparous and does not produce a shelled egg (Pilsbry 1906), each of these eggs has been counted as an individual of L. gracilis.

Lamellaxis gracilis is a resident of gardens and other disturbed habitats and may be an indicator of agricultural activities (Christensen and Kirch in press). Although living individuals of this species are commonly found in such situations on O'ahu, no fresh shells of L. gracilis were found in leaf litter from Barber's Point.

This species has often been cited as Opeas gracile. Solem (1978) reports that Opeas oparanum (Pfeiffer, 1845) is another synonym.

Pseudopeas tuckeri (*Pfeiffer, 1846*)

This poorly-known species is an exotic snail undoubtedly introduced by modern commerce. It has not been previously reported in the Hawaiian Islands. Although empty shells of this species were found in leaf litter at Site B6-78, no living individuals were found there or at other sites. The shell of Pseudopeas tuckeri bears spiral-striate embryonic whorls and crenulate sutures, characters that distinguish this species from Lamellaxis gracilis. These features are indiscernible in worn shells and in some immature specimens. At Site B6-78, where these two species co-occurred, shells not definitely referable to one or the other are listed as "Subulinidae (unidentified)".

Incertae Sedis

A few shells, too incomplete or immature even for family-level determination, are listed in the tables of data as "unidentified."

RESULTS

Results of the analyses are presented below by individual site. Refer to Hammatt and Folk (ARCH Report) for further information on Sites 2624, 2723, 2712, and 2725.

SITE OA-B6-78

This site, a large sinkhole with an opening 2.5 by 1.5 meters and a depth of 1.9 meters to the top of the deposit, was the subject of salvage excavations by Sinoto (1978:21-24). The sink's deposits yielded a large number of fossil birdbones, particularly in the upper 35 centimeters. Fortunately, the excavators left some intact deposit of the upper levels near the walls of the sink, and half of the lower breccia zone remains unexcavated. Thus, we were able to obtain a continuous column of nine samples (to 85 centimeters below the original sink floor). Because we began sampling into the exposed face of the lower breccia zone (Layer III), before sampling the remnant upper levels, our sample numbers are from top to bottom: 6, 7, 8, 9, 1, 2, 3, 4, 5.

The site's stratigraphy was reported by Sinoto (1978:Figure 11 and Table 4), and was also the subject of a detailed sedimentary analysis by Morgenstein (1978). Unfortunately, the two accounts are discrepant in terms of layer designations and thicknesses, although they largely agree in description of the sediments. Sinoto's "overburden" is essentially Morgenstein's Layer I. Morgenstein's Layer II, the primary zone of birdbone deposition, is coincident with Sinoto's Layer I and part of Layer II (based on depth data presented in Sinoto's Table 4). Morgenstein's Layer III is divided by Sinoto into Layers III and IV.

Based upon our field examination of the remaining portion of the stratigraphic column, we believe that Morgenstein's designations are sufficient to delineate the major stratigraphic units. The following is a summary of the depositional sequence, with depths as measured at the time of landsnail sample collection:

Layer	Depth	Description
I	0-10 cm.	Black (10YR 2/1)* organic 0 and A1 horizons, relatively loose.
II	10-40 cm.	Brown (7.5YR 5/4) sandy loam with angular fragments of limestone. Primary zone of birdbones.
III	40-90+ cm.	Reddish yellow (5YR 5/6) deposit of limestone breccia in a matrix of sandy loam.

The results of snail analysis are given in Table 10 and are plotted in Figure 94. It is apparent that the Layer I faunal assemblage is the most divergent of the entire set, with significantly reduced quantities of the native genera Orobophana, Leptachatina, Cookeconcha, and Endodonta. The abundance of the introduced Gastrocopta and Pseudopeas in Layer I represents historic-period change.

Layer II (samples 7-9) is clearly a zone of change. In this stratum, there is significant decrease in Cookeconcha, and increases in Lamellidea, Tornatellides, Lyropupa, and Succinea. The species Lamellaxis gracilis is present in the upper two-thirds of Layer II (six specimens). This species was apparently spread throughout the inner Pacific by prehistoric Austronesian peoples (cf. Christensen and Kirch in press). If its presence in Layer II is not the result of mixing then one could suggest that man was also active in the area by that time. Layer II is the principal zone of fossil birdbone. This indication of human activity (however tentative) is of considerable interest.

Layer III shows a total absence of any introduced snail species, although there are changes in its faunal composition from top to bottom. These may represent local changes in vegetation. The gradual increases in Orobophana and Leptachatina might indicate increasing vegetative cover.

The extent to which the faunal sequence graphed in Figure 92 is graded can be tested with the use of a similarity matrix, as described

*Munsell Color Chart designation

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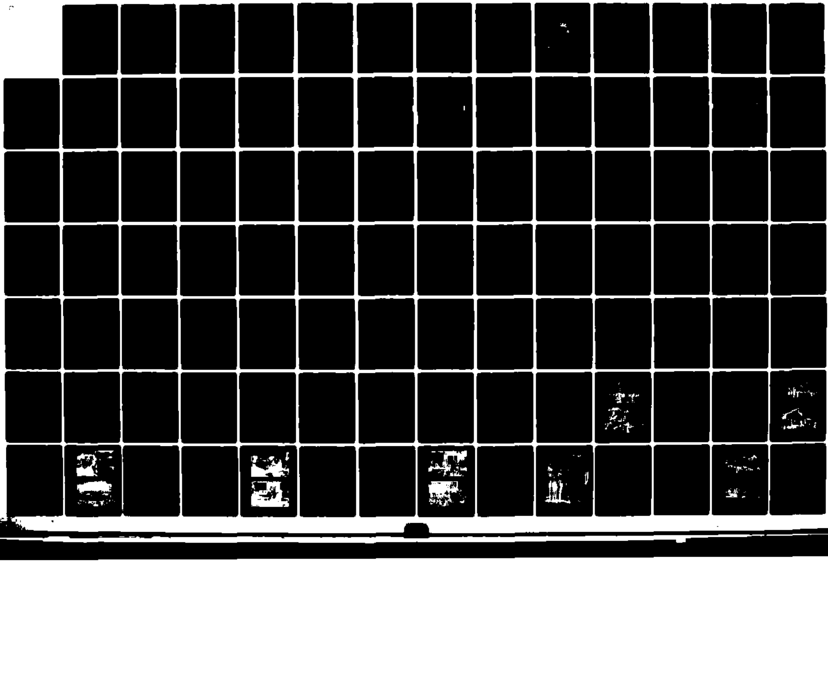
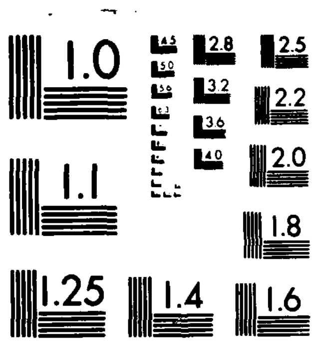




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE 10

LANDSNAIL SAMPLE DATA FOR SITE OA-B6-7[cut off]

Sample No.	6	7	8	9	1	2
Layer	I	II	II	II	III	III
Depth	0-10	10-20	20-30	30-40	40-50	50-6[cut off]
Dry Weight (g)	247.9	354.6	460.0	176.3	419	351.[cut off]
Weight of 4 mm frac. (g)	80.8	136.7	237.3	98.0	274.9	149.[cut off]
Weight of 1 mm frac. (g)	69.6*	40.4	52.9	18.9	34.7	57.[cut off]
Total Snails Counted	4950	1311	2056	536	256	207
Snails/100 g	1997	370	447	304	61	59

	N	%	N	%	N	%	N	%	N	%	N
NE Orobophana uberta	385	7.8	203	15.5	325	15.8	91	17.0	55	21.5	45
FW Assiminea nitida	--	--	--	--	2	0.1	--	--	--	--	--
NL Lamellidea spp.	1212	24.5	219	16.7	308	15.0	65	12.1	32	12.5	30
NL Tornatellides spp.	508	10.3	112	8.5	43	2.1	5	0.9	--	--	--
NE Leptachatina cookei	23	0.5	18	1.4	32	1.6	3	0.6	3	1.2	--
NE L. subcylindracea	209	4.2	231	17.6	459	22.3	103	19.2	58	22.7	35
NE L. sp.	--	--	--	--	--	--	--	--	--	--	--
NE Amastridae (unident.)	--	--	--	--	--	--	--	--	--	--	--
NL Lyropupa perlonga	465	9.4	55	4.2	16	0.8	3	0.6	2	0.8	--
NE Nesopupa litoralis	75	1.5	10	0.8	30	1.5	18	3.4	7	2.7	4
I Gastrocopta servilis	424	8.6	1	0.1	--	--	--	--	--	--	--
NE Pupoidopsis hawaiiensis	38	0.8	2	0.2	2	0.1	1	0.2	--	--	--
NL Succinea spp.	758	15.3	44	3.4	12	0.6	7	1.3	--	--	+
NE Cookeconcha n. sp.	220	4.4	273	20.8	586	28.5	180	33.6	69	27.0	53
NE Endodonta n. sp.	139	2.8	137	10.5	236	11.5	60	11.2	32	12.5	40
I Lamellaxis gracilis	236	4.8	2	0.2	4	0.2	--	--	--	--	--
I Pseudopeas tuckeri	145	2.9	3	0.2	--	--	--	--	--	--	--
I Subulinidae (unident.)	113	2.3	1	0.1	--	--	--	--	--	--	--
UNIDENTIFIED	--	--	--	--	1	0	--	--	--	--	--

Abbreviations: NE = native, extinct; NL = native, extant; I = introduced; FW = freshwat[cut off]

* Weight of total 1 mm fraction; smaller sub-sample of 28.9 g sorted for snails.

[a] Possible contaminant.

TABLE 10

LANDSNAIL SAMPLE DATA FOR SITE OA-B6-78

8		9		1		2		3		4		5	
II		II		III		III		III		III		III	
20-30		30-40		40-50		50-60		60-70		70-80		80-90	
460.0		176.3		419		351.7		500		707.9		230	
237.3		98.0		274.9		149.5		328.6		533.0		116.4	
52.9		18.9		34.7		57.0		49.8		42.7		36.6	
2056		536		256		207		197		351		752	
447		304		61		59		39		50		327	
N	%	N	%	N	%	N	%	N	%	N	%	N	%
325	15.8	91	17.0	55	21.5	45	21.7	40	20.3	60	17.1	109	14.5
2	0.1	—	—	—	—	—	—	—	—	—	—	—	—
308	15.0	65	12.1	32	12.5	30	14.5	28	14.2	52	14.8	159	21.1
43	2.1	5	0.9	—	—	—	—	1	0.5	4	1.1	9	1.2
32	1.6	3	0.6	3	1.2	—	—	—	—	7	2.0	12	1.6
459	22.3	103	19.2	58	22.7	35	16.9	29	14.7	34	9.7	29	3.9
—	—	—	—	—	—	—	—	—	—	—	—	8	1.1
—	—	—	—	—	—	—	—	—	—	—	—	10	1.3
16	0.8	3	0.6	2	0.8	—	—	3	1.5	9	2.6	48	6.4
30	1.5	18	3.4	7	2.7	4	1.9	1	0.5	7	2.0	43	5.7
—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	0.1	1	0.2	—	—	—	—	—	—	—	—	—	—
12	0.6	7	1.3	—	—	+	+	1	0.5	—	—	2	0.3
586	28.5	180	33.6	69	27.0	53	25.6	59	29.9	91	25.9	190	25.3
236	11.5	60	11.2	32	12.5	40	19.3	34	17.3	87	24.8	132	17.6
4	0.2	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	0	—	—	—	—	—	—	1	0.5	—	—	1	0.1

ive, extant; I = introduced; FW = freshwater, extinct; NL = native, extant.

mple of 28.9 g sorted for snails.

2

SAVE FOR FIGURE 94:
LANDSNAIL DIAGRAM FOR SITE OA-B6-78

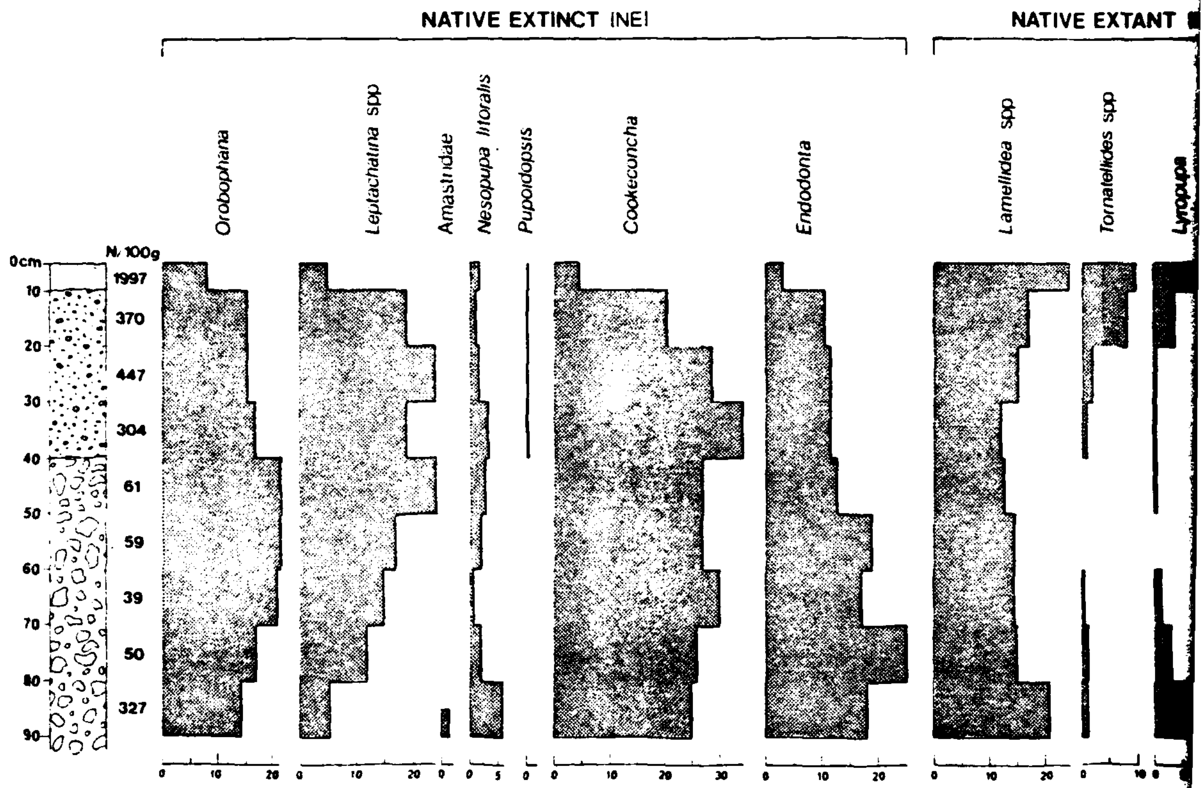


FIGURE 94 LANDSNAIL DIAGRAM FOR SITE OA-B6-78.

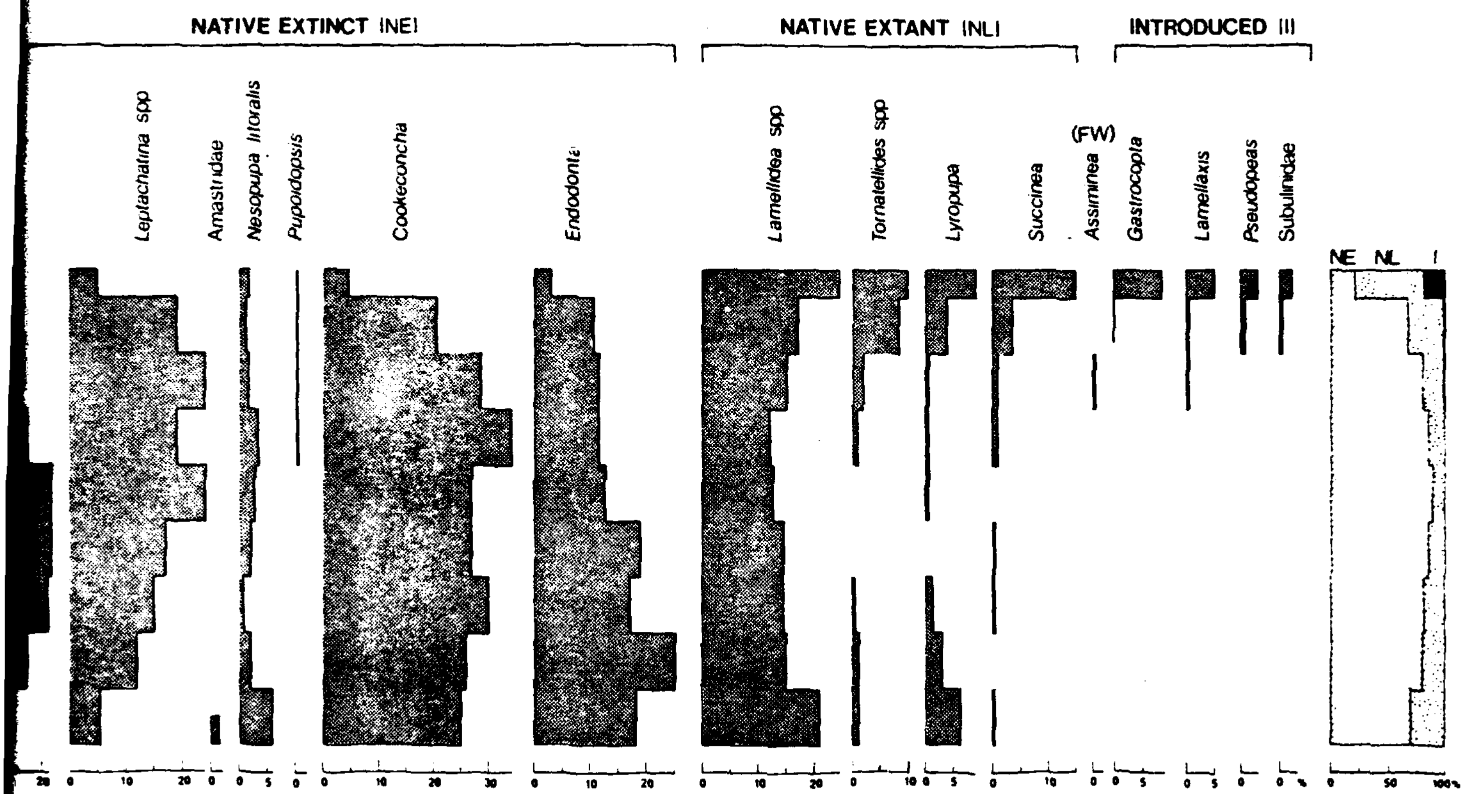


FIGURE 94 LANDSNAIL DIAGRAM FOR SITE OA-B6-78.

2

above. Proportional similarity values for B6-78 samples are given in Table 11 and are plotted as a shaded matrix in Figure 93. The grading index (Q) for this matrix is 123 ($Q = 0$ for a perfectly graded matrix). The greatest possible Q value for any matrix is given by the formula:

For a 9 X 9 matrix as with B6-78, $Q_{max} = 546$. The Q/Q_{max} ratio for Site B6-78 is thus 0.23, which indicates that the stratigraphic sequence is definitely nonrandom (Pielou 1979:Figure 3) and reasonably well graded. Examination of the shaded matrix also reveals (1) the divergence of the Layer I assemblage, and (2) a slightly higher internal clustering between sample from Layers II and III. This supports the interpretation of the faunal succession in terms of the observed stratigraphic units. For example, within Layer III, Sample 2 links most closely with Samples 1 and 3 (above and below it). Within Layer II, Sample 8 links most closely with Samples 9 and 1 (both lower in the column).

In sum, the landsnail sequence from Site B6-78 can be interpreted as a nonrandom, reasonably well-graded faunal succession. Gradual changes in Layer III may represent local vegetational changes. More drastic change is indicated in Layer II (the fossil bird bone zone), and the possible role of humans is suggested by the presence of *Lamellaxis*. Historic-period changes are clearly evidenced in Layer I.

SITE 2624

Site 2624 is a large sinkhole about 3 to 4 meters in diameter and 3 meters deep (refer to Figures 91 and 92). At the time of sampling for landsnails, the majority of the deposit had been excavated for fossil bird bones by the ARCH team. The landsnail column was taken from a profile in the center of the sink, about one meter from the limestone walls (adjacent to TP-4, E face). The stratigraphic

TABLE 11

PROPORTIONAL SIMILARITY MATRIX FOR SITE B6-78

Sample Numbers

6	7	8	9	1	2	3	4	5	Sample Numbers
	0.54	0.40	0.36	0.35	0.35	0.36	0.40	0.50	6
		0.85	0.81	0.80	0.79	0.79	0.77	0.74	7
			0.90	0.93	0.86	0.87	0.83	0.76	8
				0.89	0.85	0.87	0.80	0.73	9
					0.91	0.88	0.82	0.73	1
						0.93	0.88	0.78	2
							0.87	0.78	3
								0.83	4
									5

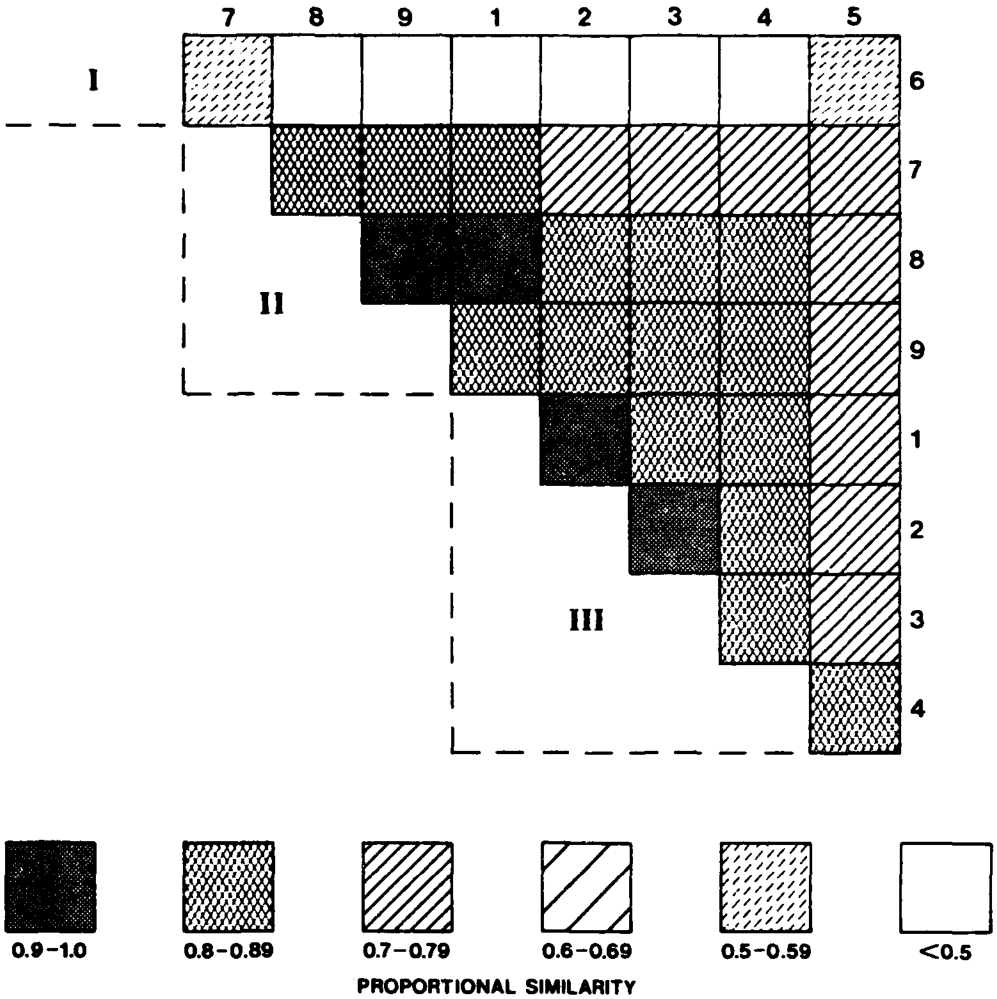


FIGURE 95 PROPORTIONAL SIMILARITY MATRIX FOR SITE OA-B6-78.

profile was as follows:

ARCH Strata	Depth	Description
I	0-2 cm.	O and A1 horizon of organic matter and litter.
II	2-23/24 cm.	Aeolian silt-loam with fine limestone gravel. 7.5YR 4/4(moist) grading downwards to 10YR 5/3 (moist).
III	23/24-27 cm.	Compacted deposit of unconsolidated limestone breccia 10YR 5/3 (moist).

Results of the landsnail analysis are given in Table 12 and plotted in Figure 96. It is evident that this series of samples represents a well-graded progression of faunal change. Most salient are the continual decreases in Orobophana and Endodonta, and the increases in Lamellidea, Tornatellides, and Succinea. The historically introduced Gastrocopta increases in abundance in the upper 7 centimeters. The two specimens in the 7-12 cm. sample probably derives from the contact zone of Samples 2 and 3. Most significantly, the prehistorically introduced Lamellaxis is present throughout the deposit, raising the question of the potential role of man in this sequence of faunal, and presumably vegetational, change.

The interpretation of the 2624 stratigraphic column as a well-graded series is borne out by matrix analysis (Table 13 and Figure 97). The grading index, Q, for this matrix is only 3, and the Q/Q_{max} ratio of 0.035 (Q_{max} = 85) indicates a highly significant nonrandom pattern.

SITE 2712

This is a habitation feature chosen for landsnail analysis to contrast an faunal assemblage in an occupation site with those from the paleontological sinks. The sampling column was cut from the E face of the SE quadrant of grid unit N1E1. The stratigraphic profile at this point was as follows:

TABLE 12

LANDSNAIL SAMPLE DATA FOR SITE 2624

Sample No.	1	2	3	4
Layer	I	II	II	II
Depth	0–2	2–7	7–12	12–17
Dry Weight (g)	62.0	208.3	145.9	97.7
Weight of 4 mm frac. (g)	12.6	48.6	33.0	21.7
Weight of 1 mm frac. (g)	8.5	26.6	26.7	22.0
Total Snails Counted	374.0	1613.0	1759.0	1560.0
Snails/100 g	603.0	774.0	1205.0	1597.0

	N	%	N	%	N	%	N
NE Orobophana uberta	43	11.5	236	14.6	328	18.6	306
FW Assiminea nitida	1	0.3	1	0.1	1	0.1	1
NL Lamellidea spp.	68	18.2	349	21.6	339	19.3	305
NL Tornatellides spp.	53	14.2	346	21.5	330	18.8	291
NE Leptachatina cookei	—	—	—	—	8	0.5	9
NE L. subcylindracea	14	3.7	47	2.9	94	5.3	112
NE Amastridae (unident.)	—	—	+	+	+	+	—
NL Lyropupa perlonga	21	5.6	60	3.7	115	6.5	87
NE Nesopupa litoralis	—	—	10	0.6	4	0.2	16
NE N. newcombi	18	4.8	75	4.6	53	3.0	16
I Gastrocopta servilis	46	12.3	69	4.3	2	0.1	—
NE Pupoidopsis hawaiiensis	5	1.3	21	1.3	27	1.5	11
NL Succinea spp.	20	5.3	120	7.4	63	3.6	26
NE Cookeconcha n. sp.	18	4.8	52	3.2	85	4.8	73
NE Endodonta n. sp.	52	13.9	168	10.4	297	16.9	304
I Lamellaxis gracilis	15	4.0	59	3.7	11	0.6	3
UNIDENTIFIED	—	—	—	—	2	0.1	—

Abbreviations: NE = native, extinct; NL = native, extant; I = introduced; FW = freshwater

TABLE 12
LANDSNAIL SAMPLE DATA FOR SITE 2624

1	2	3	4	5	6
I	II	II	II	II	II
0-2	2-7	7-12	12-17	17-22	22-23/24
62.0	208.3	145.9	97.7	98.0	56.7
12.6	48.6	33.0	21.7	24.8	11.5
8.5	26.6	26.7	22.0	20.5	9.3
374.0	1613.0	1759.0	1560.0	889.0	[illegible].0
603.0	774.0	1205.0	1597.0	907.0	2.0

N	%	N	%	N	%	N	%	N	%	N	%
43	11.5	236	14.6	328	18.6	306	19.6	225	25.3	70	26.7
1	0.3	1	0.1	1	0.1	1	0.1	—	—	2	0.8
68	18.2	349	21.6	339	19.3	305	19.6	147	16.5	36	13.7
53	14.2	346	21.5	330	18.8	291	18.7	93	10.5	15	5.7
—	—	—	—	8	0.5	9	0.6	3	0.3	—	—
14	3.7	47	2.9	94	5.3	112	7.2	55	6.2	9	3.4
—	—	+	+	+	+	—	—	—	—	2	0.8
21	5.6	60	3.7	115	6.5	87	5.6	33	3.7	12	4.6
—	—	10	0.6	4	0.2	16	1.0	12	1.3	2	0.8
18	4.8	75	4.6	53	3.0	16	1.0	12	1.3	3	1.1
46	12.3	69	4.3	2	0.1	—	—	—	—	—	—
5	1.3	21	1.3	27	1.5	11	0.7	4	0.4	1	0.4
20	5.3	120	7.4	63	3.6	26	1.7	22	2.5	3	1.1
18	4.8	52	3.2	85	4.8	73	4.7	64	7.2	9	3.4
52	13.9	168	10.4	297	16.9	304	19.5	216	24.3	93	35.5
15	4.0	59	3.7	11	0.6	3	0.2	3	0.3	4	1.5
—	—	—	—	2	0.1	—	—	—	—	1	0.4

xtinct; NL = native, extant; I = introduced;
r

2

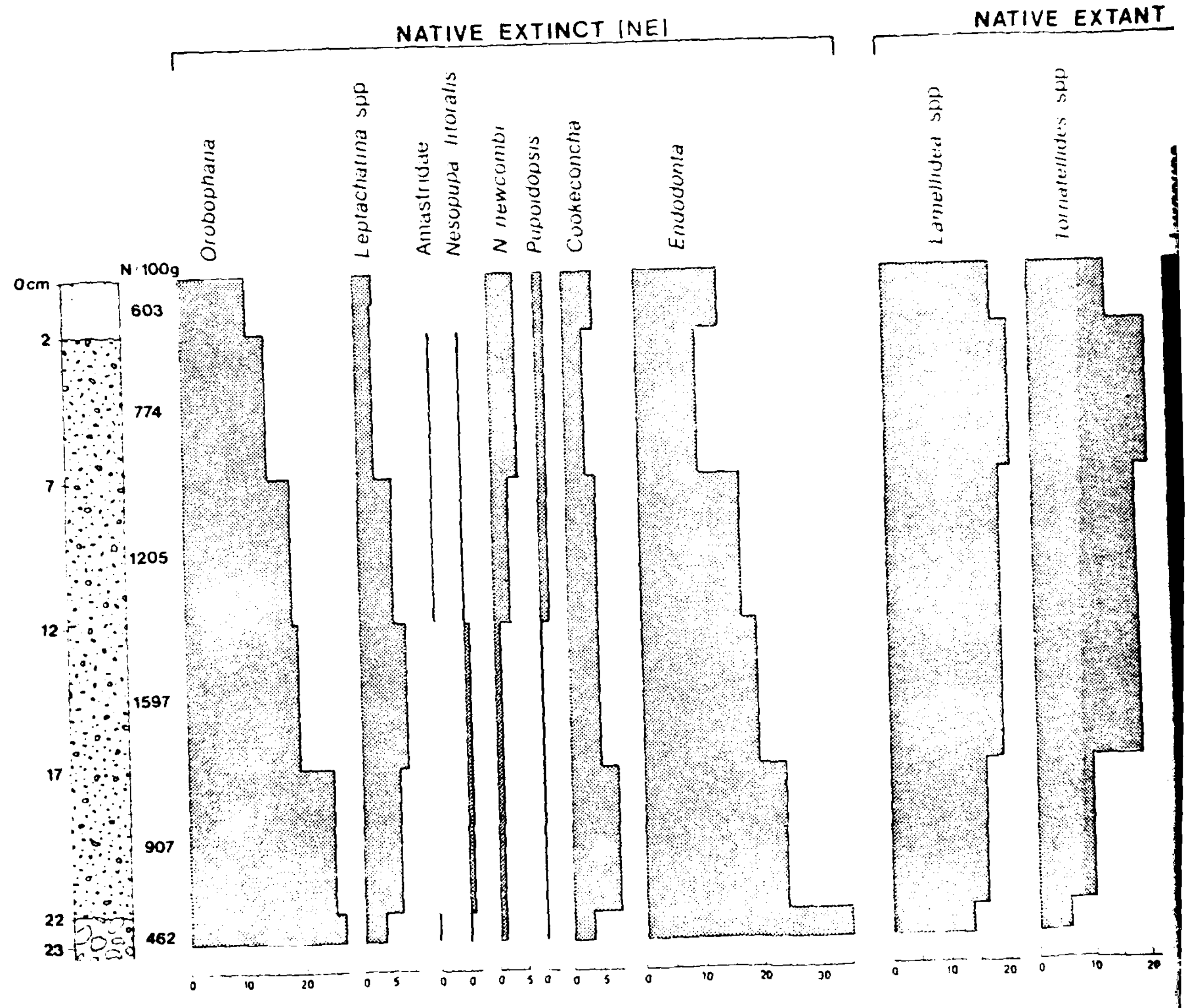


FIGURE 96 LANDSNAIL DIAGRAM FOR SITE 50-80-12-262

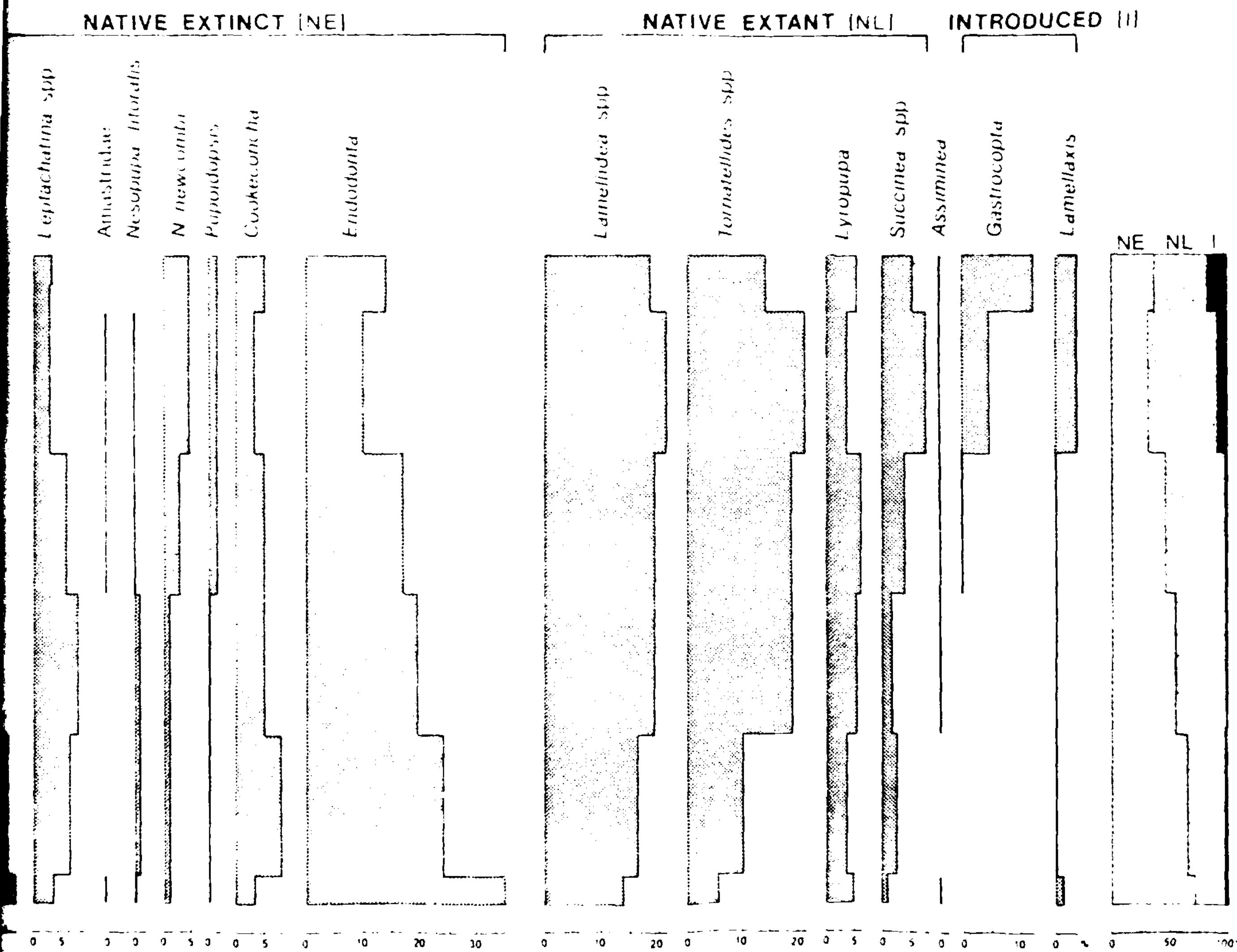


FIGURE 96 LANDSNAIL DIAGRAM FOR SITE 50-80-12-2624.

TABLE 13

PROPORTIONAL SIMILARITY MATRIX FOR SITE 2624

Sample Numbers

2	3	4	5	6	Sample Numbers
0.83	0.81	0.75	0.69	0.61	1
	0.82	0.77	0.67	0.59	2
		0.94	0.82	0.70	3
			0.85	0.74	4
				0.83	5

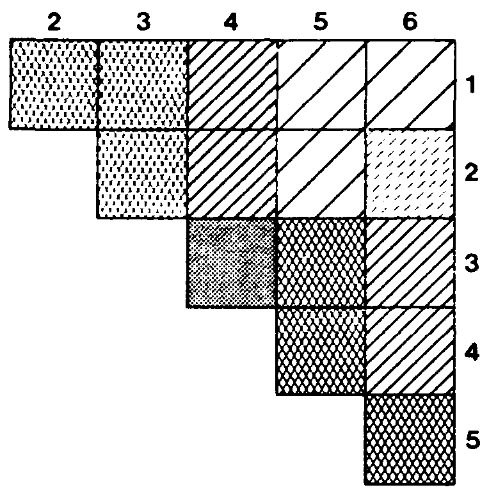


FIGURE 97 PROPORTIONAL SIMILARITY MATRIX FOR SITE 50-80-12-2624.

ARCH Strata	Depth	Description
I	0-3 cm.	O horizon; organic litter
I	3-6 cm.	A1 horizon. Overburden of aeolian silt and organic matter. Very dark grey (5YR 3.1).
II	6-7/9 cm.	Grey to light grey(5YR 5-7/1) cultural deposit, color becoming lighter with increasing depth. Compacted, with marine shells and other midden material.
	[7/9-11 cm.	Irregular contact zone between Layers I-II; landsnails very abundant.]
III	7/9-27 cm.	Culturally sterile, decomposed limestone; compacted; gravelly. Light grey (5YR 7/1).

Results of the landsnail analysis are presented in Table 14 and are plotted in Figure 98. The faunal sequence indicates rather drastic changes beginning with the onset of human habitation. The Layer III assemblage correlates fairly closely with the upper part of Layer III in Site B6-78. With the beginning of habitation, there are major decreases in Orobophana and Leptachatina, increases in Lamellidea and Lyropupa, and the significant addition of Tornatellides and Succinea. One specimen of the Polynesian introduction Lamellaxis and three specimens of the historically introduced Gastrocopta also appear. The presence of at least the Gastrocopta may be the result of mixing from upper levels during sampling. Following abandonment of the habitation site, further change occurred, including continued increases in Lamellidea and Tornatellides, drastic decrease in Orobophana, extirpation of Leptachatina, and major increase in Gastrocopta. The influence of man on the local ecology seems unquestionable in the present case. The pattern of change in this habitation site is similiar to that in the upper portions of the two birdbone-bearing limestone sinks.

TABLE 14

LANDSNAIL SAMPLE DATA FOR SITE 2

Sample No.	1		2		3		4
ARCH Strata	I		I		II		II/III
Depth (cm)	0-3		3-6		6-7/9		7/9-1
Dry Weight (g)	59.1		100.1		250.4		99.1
Weight of 4 mm frac. (g)	15.4		36.2		104.0		4.3
Weight of 1 mm frac. (g)	5.5		10.3		18.0		7.7
Total Snails Counted	218.0		132.0		318.0		183.0
Snails/100 g	369.0		132.0		127.0		185.0
	N	%	N	%	N	%	N
NE Orobophana uberta	5	2.3	5	3.8	111	34.9	89
NL Lamellidea spp.	58	26.6	44	33.3	69	21.7	30
NL Tornatellides spp.	28	12.8	14	10.6	12	3.8	--
NE Leptachatina cookei	--	--	--	--	11	3.5	11
NE L. subcylindracea	--	--	--	--	14	4.4	28
NE L. sp.	1	0.5	--	--	--	--	--
NL Lyropupa perlonga	+	+	1	0.8	41	12.9	8
NE Nesopupa litoralis	--	--	--	--	6	1.9	--
I Gastrocopta servilis	110	50.5	58	43.9	3	0.9	--
NL Succinea spp.	16	7.3	10	7.6	28	8.8	--
NE Cookeconcha n. sp.	--	--	--	--	2	0.6	2
NE Endodonta n. sp.	+	+	--	--	19	6.0	13
I Lamellaxis gracilis	--	--	--	--	1	0.3	--
UNIDENTIFIED	--	--	--	--	1	0.3	2

Abbreviations: NE = native, extinct; NL = native, extant; I = introduced; FW = fresh

TABLE 14

LANDSNAIL SAMPLE DATA FOR SITE 2712

	1		2		3		4		5	
	I		I		II		II/III		III	
	0-3		3-6		6-7/9		7/9-18		18-27	
	59.1		100.1		250.4		99.1		112.4	
c. (g)	15.4		36.2		104.0		4.3		8.2	
c. (g)	5.5		10.3		18.0		7.7		5.9	
d	218.0		132.0		318.0		183.0		33.0	
	369.0		132.0		127.0		185.0		30.0	
	N	%	N	%	N	%	N	%	N	%
rta	5	2.3	5	3.8	111	34.9	89	48.6	16	48.5
	58	26.6	44	33.3	69	21.7	30	16.4	5	15.2
p.	28	12.8	14	10.6	12	3.8	—	—	—	—
okei	—	—	—	—	11	3.5	11	6.0	+	+
ea	—	—	—	—	14	4.4	28	15.3	—	—
	1	0.5	—	—	—	—	—	—	—	—
aga	+	+	1	0.8	41	12.9	8	4.4	2	6.1
is	—	—	—	—	6	1.9	—	—	3	9.1
lis	110	50.5	58	43.9	3	0.9	—	—	—	—
	16	7.3	10	7.6	28	8.8	—	—	—	—
sp.	—	—	—	—	2	0.6	2	1.1	—	—
p.	+	+	—	—	19	6.0	13	7.1	7	21.2
	—	—	—	—	1	0.3	—	—	—	—
	—	—	—	—	1	0.3	2	1.1	—	—

= native, extinct; NL = native, extant; I = introduced; FW = freshwater

2

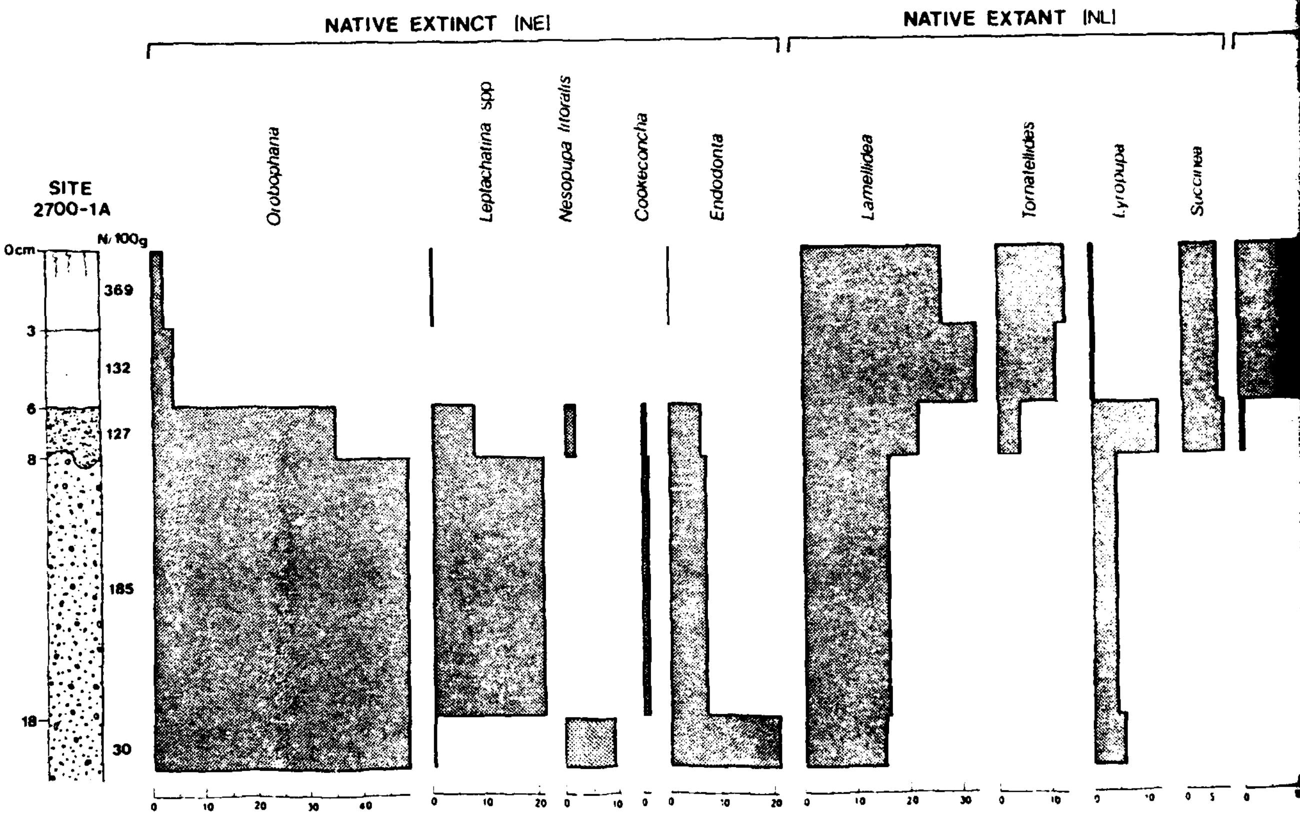


FIGURE 98 LANDSNAIL DIAGRAM FOR SITE 50-80-12-2712.

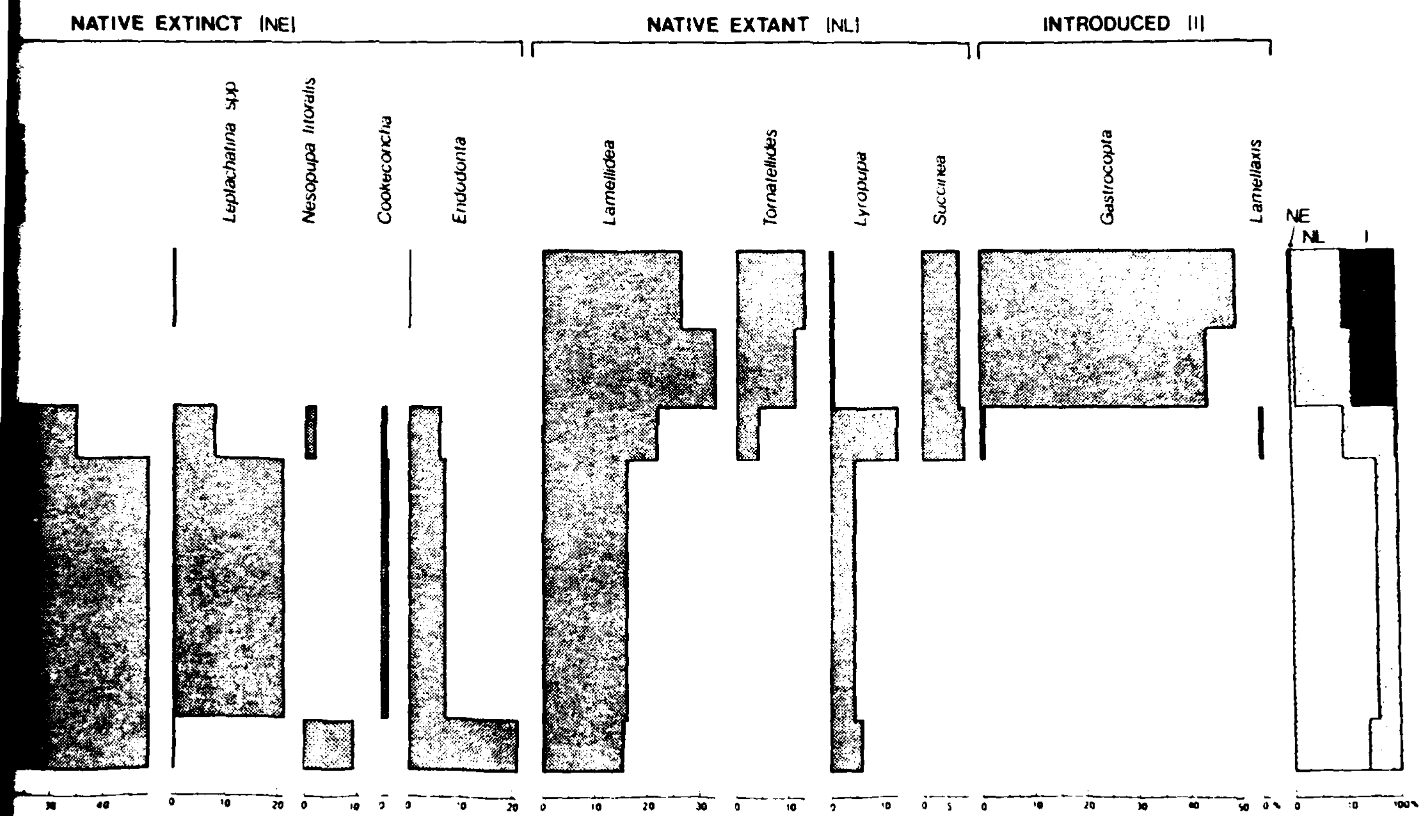


FIGURE 98 LANDSNAIL DIAGRAM FOR SITE 50-80-12-2712.

2

SITE 2723

This is a small C-shaped shelter built of limestone slabs, with an interior floor area of ca. 4 m^2, on open limestone. A 50-cm^2 test pit had been excavated by the ARCH team, exposing a thin cultural deposit with limited quantities of shellfish and bone midden. The stratigraphic column is as follows:

ARCH Strata	Depth	Description
I	0-3 cm.	O horizon; organic litter.
I/II	3-8 cm.	A1 horizon and zone of cultural material; light grey.
III	8-13/20 cm.	Decomposed limestone distributed in pockets in the limestone bedrock.

Results of landsnail analysis are reported in Table 15 and plotted in Figure 99. The sequence of faunal change closely parallels that of Site 2712 except for the larger number of Gastrocopta in the cultural layer. Because of the loose matrix and shallow stratigraphic collumn, mixing may have occured.

SITE 2725

The final site chosen for snail analysis is a small sinkhole, ca. 2 to 3 meters in diameter and .5 to .75 meters deep, with a low wall of limestone slabs built up in the east edge of the sink. The ARCH team had excavated a 25-centimeter square test pit into the floor of the sink and had judged the feature to be culturally sterile. A column of three samples was taken for comparision with the deep, bird bone-bearing sinks and with the habitation sites. The stratigaphic profile is as follows:

ARCH Strata	Depth	Description
I/II	0-10 cm.	O and A1 horizons. Gravelly soil with charcoal flecks. Very dark grey.
III	10-16/17 cm.	Compacted, transitional zone from dark organic layer into decomposed limestone floor of sink.

Results of snail analysis are reported in Table 16 and plotted in Figure 99. This faunal sequence contrasts markedly with those from all other sites. The samples contain 88% to 98% Assiminea nitida. This is an amphibious snail normally associated with brackish-water environments. While the occasional presence of shells of this species in a site may be due to random wandering and they may not be absolutely tied to water, the great abundance of Assiminea at Site 2725 is not explicable by chance contamination. Furthermore, there is no evidence to suggest that this shallow sink was ever permanently flooded. Therefore, we propose that this faunal assemblage indicates human transport of mud (perhaps with weeds for mulch) from a nearby brackish-water pond. The purpose would be to improve soil quality in the sink. This is consistent with ethnohistorical accounts of Hawaiian agronomic practices and with the presence of a possible windbreak wall along the edge of the sink. Sampling of other shallow sinks in the area could show similar assemblages.

TABLE 15

LANDSNAIL SAMPLE DATA FOR SITE 2723

Sample No.	1	2	3
ARCH Strata	I	I/II	III
Depth	0-3	3-8	8-13/20
Dry Weight (g)	44.2	120.2	64.5
Weight of 4 mm frac. (g)	11.7	32.7	9.1
Weight 1 mm frac. (g)	7.9	13.2	5.3
Total Snails Counted	160.0	603.0	112.0
Snails/100 g	362.0	502.0	174.0

	N	%	N	%	N	%
NE *Orobophana uberta*	1	0.6	+	+	12	10.7
FW *Assiminea nitida*	--	--	3	0.5	1	0.9
NL *Lamellidea* spp.	28	17.5	198	32.8	27	24.1
NL *Tornatellides* spp.	33	20.6	245	40.6	19	17.0
NE *Leptachatina cookei*	--	--	--	--	5	4.5
NE *L. subcylindracea*	--	--	--	--	4	3.6
NE *L.* sp.	--	--	+	+	--	--
NL *Lyropupa perlonga*	+	+	19	3.2	19	17.0
I *Gastrocopta servilis*	79	49.4	82	13.6	5	4.5
NL *Succinea* spp.	16	10.0	55	9.1	20	17.9
UNIDENTIFIED	3	1.9	1	0.2	--	--

Abbreviations: NE = native, extinct; NL = native, extant; I = introduced; FW = freshwater

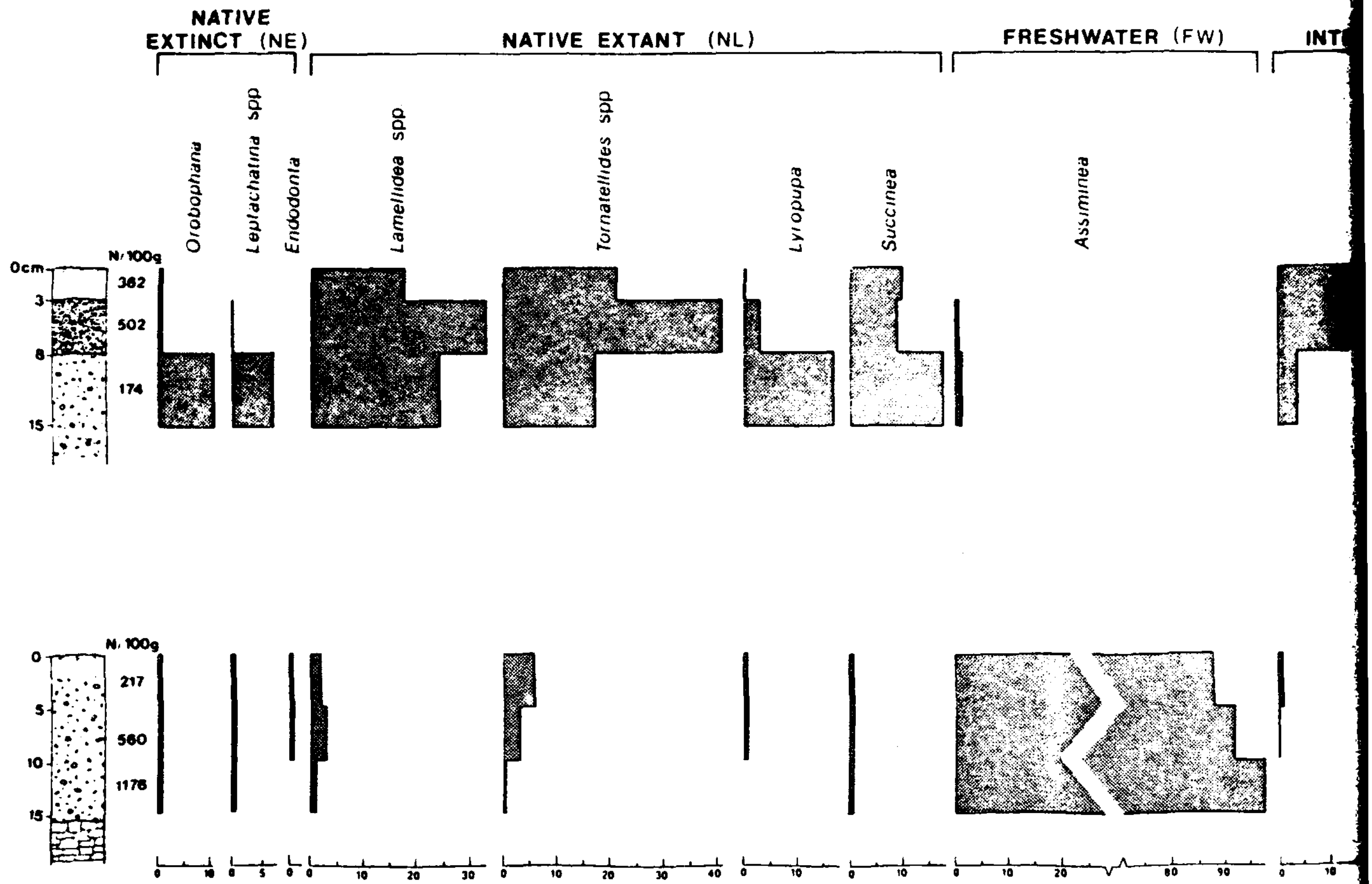
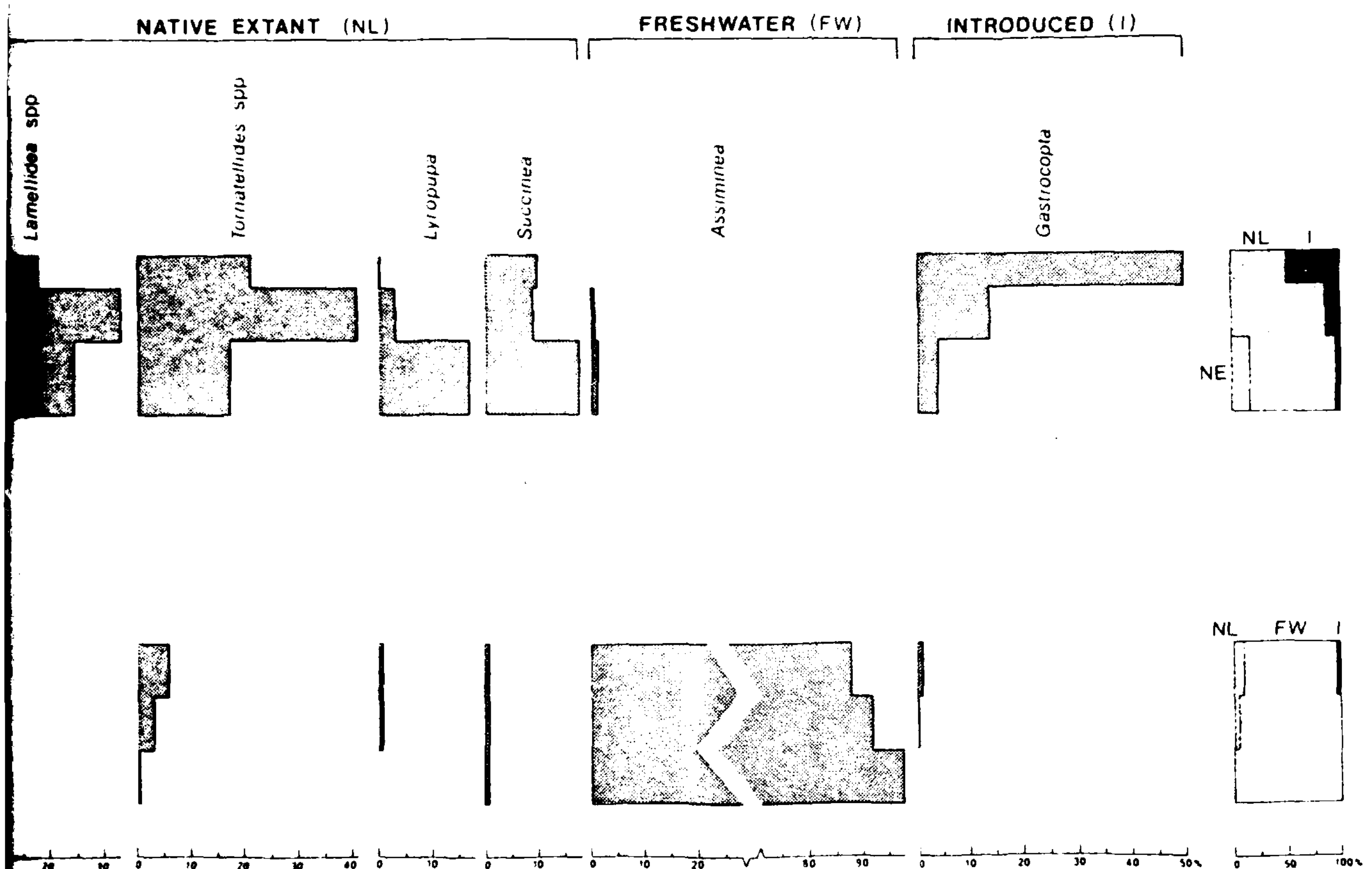


FIGURE 99 LANDSNAIL DIAGRAMS FOR SITES 50-80-12-2723(UPPER) AND 50-80-12-2725(LOWER).



SNAIL DIAGRAMS FOR SITES 50-80-12-2723(UPPER) AND
0-12-2725(LOWER).

TABLE 16

LANDSNAIL SAMPLE DATA FOR SITE 2725

Sample No.	1	2	3
ARCH Strata	I	I/II	III
Depth	0-5	5-10	10-16/17
Dry Weight (g)	168.1	159.5	100.3
Weight of 4 mm frac. (g)	102.1	88.7	23.4
Weight of 1 mm frac. (g)	24.7	25.4	17.3
Total Snails Counted	365.0	893.0	1180.0
Snails/100 g	217.0	560.0	1176.0

	N	%	N	%	N	%
NE *Orobophana uberta*	3	0.8	9	1.0	5	0.4
FW *Assiminea nitida*	321	87.9	818	91.6	1162	98.5
NL *Lamellidea* spp.	6	1.6	21	2.4	8	0.7
NL *Tornatellides* spp.	22	6.0	26	2.9	3	0.3
NE *Leptachatina cookei*	--	--	1	0.1	--	--
NE *L. subcylindracea*	2	0.5	4	0.4	--	--
NE *L.* sp.	--	--	--	--	+	+
NL *Lyropupa perlonga*	1	0.3	4	0.4	--	--
I *Gastrocopta servilis*	4	1.1	2	0.2	--	--
NL *Succinea* spp.	2	0.5	8	0.9	2	0.2
NE *Endodonta n.* sp.	+	+	+	+	--	--
UNIDENTIFIED	4	1.1	--	--	--	--

Abbreviations: N = native, extinct; NL = native, extant; I = introduced; FW = freshwater.

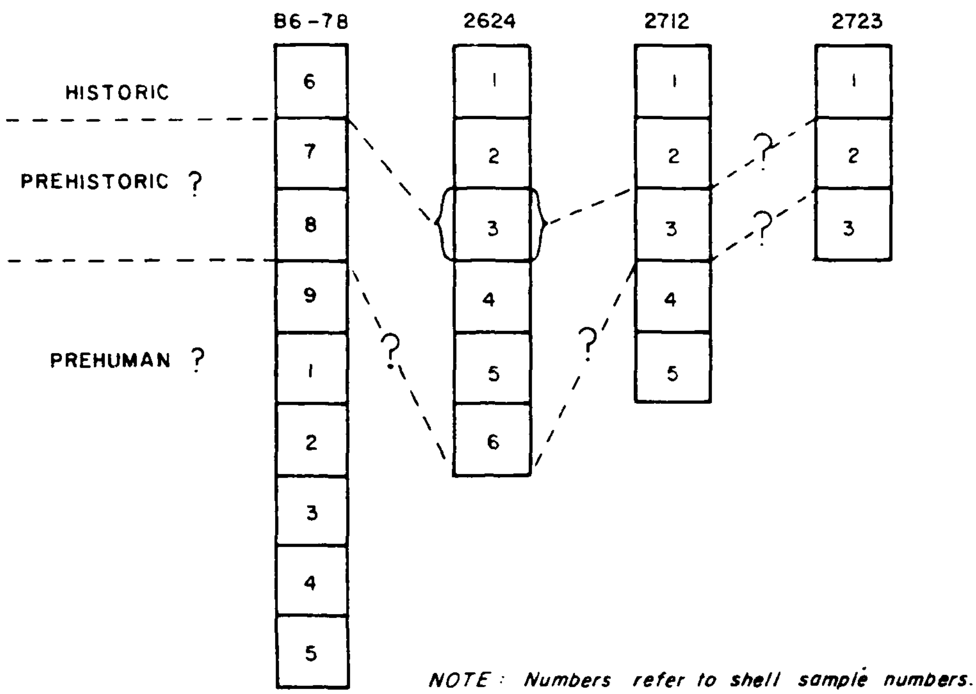


FIGURE 100 TENTATIVE CORRELATION BETWEEN BARBER'S POINT STRATIGRAPHIC COLUMNS.

GENERAL DISCUSSION

Of particular concern are (1) tentative temporal correlations between the stratigraphic columns, (2) the implications for patterns of ecological change in the Barber's Point area, and (3) the possible role of both prehistoric and historic man in initiating or hastening this change.

INTER-SITE CORRELATIONS

Although there are differences in the stratigraphic columns of the sites studied, the overall pattern of faunal change is remarkably consistent and allows us to propose tentative temporal correlations between columns. Major time markers include: (1) the onset of decreases in *Orobophana*, *Leptachatina*, *Cookeconcha*, and *Endondonta*; (2) the onset of significant increases in the genera *Lamellidea*, *Tornatellides*, *Lyropupa*, and *Succinea*; (3) the appearance of the putative Polynesian introduction *Lamellaxis gracilis*; and (4) the appearance of the historically introduced *Gastrocopta* and *Pseudopeas*.

Figure 98 diagrams our proposed correlations of stratigraphic columns, based upon the landsnail evidence alone. Site B6-78 provides the longest stratigraphic sequence, and is thus of critical importance in assessing long-term ecological change. The column in Site 2624 appears to us to correlate with the upper portion of Site B6-78. The two habitation sites may span a lengthy time period, as suggested in the diagram, but their stratigraphic sections are greatly compressed and not as amenable to detailed interpretation.

Based upon the presence/absence of the introduced snail species it is possible to suggest that the temporal sequence shown in Figure 98 spans three major periods: (1) a pre-human-contact period; (2) a period of prehistoric Polynesian utilization/occupation of the area; and (3) the recent historic period. The rate and extent of ecological change seems to have increased and intensified from periods 1 to 3.

Most significant of all is the implication that Polynesian man was present when the majority of avian remains were deposited. Humans may have played a direct or indirect role in the extinction of these birds.

These tentative correlations are based solely on the landsnail evidence presented above, and have not had the benefit of any quantitative dating. While the consistency in patterning of faunal successions between sites gives us some confidence in the proposed correlations, they could be subject to revision based upon the results of a dating program. A program of careful and extensive dating--using radiocarbon, amino-acid racemization, fluorine, or other techniques is of utmost priority. Quantitative age determinations may answer the question of whether the extinction of the Barber's Point avifauna occurred during the span of human occupation.

PATTERNS OF ECOLOGICAL CHANGE

Paleoecological interpretation based upon the occurrence of landsnails in the supposedly prehuman levels of the Barber's Point sites is hindered by our incomplete knowledge of the ecological parameters of the various species present. A number of species common in these early levels are now extinct making direct observation of their habitat impossible. Data on other species are often imprecise. Malacological studies of Hawaiian terrestrial snails have been focused almost exclusively upon taxonomy for more than a century, with only passing consideration of ecology. Nevertheless, certain inferences on the general nature of the prehuman environment of the study area are possible.

Snails characteristic of moist forest conditions are absent throughout the sequence. Achatinella, Auriculella, Amastra (excluding the xerophilous subgenus Cyclamastra), Laminella, Lyropupa of the nominate subgenus, low-spired Succineidae (principally Catinella), and Philonesia are not represented in any of the sites studied. All of these occur in forested locations in the nearby Wai'anae Mountains. Several taxa (Achatinella, Catinella, and Philonesia) are abundantly represented in coastal deposits in windward O'ahu where they presumably indicate that moist forest conditions formerly extended to lower elevations (cf. Perkins 1913:xxvi-xxvii).

In contrast, the Barber's Point assemblage reflects relative aridity with native grasses, shrubs, and possibly sparse-dry forest, open-canopy tree species (such as as Erythrina, Myoporum, or Reynoldsia). The endemic xerophytic shrub Euphorbia skottsbergii (Sherff) survives in the area today. Pupoidopsis hawaiiensis, a rare species in our samples, was probably restricted to grasses in coastal locations. The species is now extinct in Hawai'i, but was known to inhabit clumps of bunchgrass (Lepturus sp.) on Christmas Island (Cooke and Neal 1928). Leptachatina cookei, L. subcylindracea, and Nesopupa litoralis are universally extinct and their ecological preferences are therefore not directly observable. However, their occurrence only in low-elevation fossil deposits, including the dry leeward coast of O'ahu, is indicative of a partiality for arid conditions. Cookeconcha n. sp. and Endodonta n. sp. are likewise universally extinct. The only closely related species found at low elevations were recorded on grasses in arid locations. Orobophana seems to prefer some degree of shrub or tree cover, and has been collected on dead leaves and twigs (Neal 1934). Nesopupa newcombi is extinct in the Barber's Point region but persists elsewhere on O'ahu. Tornatellides spp. is represented in the modern fauna of the area by a single species. Both are tolerant of a broad range of environments. Their presence is consistent with the postulated arid grassland-parkland conditions. Pupoidopsis hawaiiensis, absent from the earliest levels of Site B6-78 but sparsely represented in apparently-prehistoric levels there and at Site 2624, was probably restricted to grasses in coastal locations. The species is now extinct in Hawaii but inhabits clumps of bunchgrass (Lepturus sp.) on Christmas Island (Cooke and Neal 1928).

Later levels show a different assemblage dominated by the native taxa Lamellidea, Tornatellides, Lyropupa, and Succinea. These are tolerant of disturbed conditions as evidenced by their presence in the modern fauna of the area. Lamellidea and Tornatellides are frequently collected in disturbed vegetation (Cooke and Kondo 1960). Lyropupa (subgenus Mirapupa) is tolerant of very arid conditions. Pilsbry and

Cooke (1918-1920:259) remarked: "In every case where the junior author found living examples they were taken in open country under dead sticks and stones." Succinea can tolerate very dry conditions. This assemblage may indicate increasing aridity and decreasing vegetative cover.

In the upper levels exotic snails also appear, becoming dominant in the topmost levels. Native taxa, many of which are locally extinct, become dominated by exotic forms in all sites studied with the exception of Site 2725. In the absence of quantitative dates it is perhaps premature to conclude with certainty that man was responsible (through forest clearance and agriculture) for the extinction of much of the native landsnail fauna (and avifauna?). We believe, however, that the dates, when available, will be consistent with this conclusion.

In sum, the overall patterns of ecological change suggested by landsnail analysis are of (1) a pre-human, grassland-parkland vegetation, giving way to (2) increased aridity and decreased vegetative cover, possibly as a result of prehistoric Polynesian interference, and finally (3) a drastic change in local flora and fauna in historic times.

CONCLUSION AND RECOMMENDATION

The results reported above represent the first major application of paleo-malacological analysis to Hawaiian archaeological and paleontological sites. We have been able to document a consistent pattern of faunal succession that is doubtless a reflection of wider changes in vegetation and other biota. Most importantly, we now have tentative evidence for the presence of Polynesian man at the time of deposition of the fossil birdbones.

If a complete picture of paleo-envionmental change in the region--and man's role in this picture--is to be achieved, we feel that further paleo-malacological analysis is imperative. So far, only Site B6-78 has yielded a relatively lengthy stratigraphic sequence. Other deep sites need to be located and carefully sampled in order to confirm or revise the pattern of ecological change outlined above. We recommend that as additional salvage excavations are conducted, paleo-malacological analysis be included as an integral part of the field and laboratory studies. We also stress that a program of radiocarbon and other quantitative dating of these stratigraphic profiles be undertaken. The wealth of avifaunal materials in the Barber's Point sites has justifiably created scientific excitement; the probability of their association with prehistoric man is a problem worthy of our best analytical efforts.

APPENDIX III

A STUDY OF THE WARTIME HISTORY

OF CAMP MALAKOLE, 1940-1946

by

Robert H. Albert, B.A.

prepared for

ARCHAEOLOGICAL RESEARCH CENTER HAWAII, INC.

December 6, 1980

ACKNOWLEDGEMENTS

Attempting to unravel the wartime history of Camp Malakole during the last two months has been the equivalent of "searching for the needle in the haystack" routine. The majority of the available sources of information have been drawn from general documentaries such as command and department histories from which a narrative has been extrapolated. Attempts to locate local eye witnesses have been quite unsuccessful, with two exceptions, and they have been unavailable for interview. Nevertheless, thanks to the following people, some progress has been made.

The author wishes to express his gratitude to all who have helped contribute to this report. He is especially grateful to Ms. Fran Jackson, Archivist, War Records Depository, Sinclair Library, University of Hawaii at Manoa, and to the Real Estate Branch Staff, Army Corps of Engineers, Federal Building, downtown Honolulu.

He further wishes to acknowledge the valuable contributions of Mr. David Sox and Mr. Thompson, of the Army Corps of Engineers at Fort Shafter, O'ahu for making their records available on a number of occasions.

Thanks are also due Captain Robert Bowling, Officer-in-Charge, the Army Museum, Fort DeRussy; to Sergeant Francis T. Vaivao, 25th Infantry Division Museum Curator, Schofield Barracks; to Technical Sergeant (T-5) Wallace, Public Relations Office, Schofield Barracks; and to the Librarians at Fort Shafter, Schofield Barracks, Tripler Army Medical Center, Kaneohe Marine Corps Air Station, and the State Library of downtown Honolulu.

Special recognition is due to Colonel Kenneth W. Bandel USA (Ret.), Colonel Amos Lafaven USA (Ret.), Major Robert Macdonald, USA (Ret.), San Diego, California and Major John M. Leaf, USA (Ret), Kailua, O'ahu, Hawaii. These officers were 1940 members of the 251st California National Guard Regiment which helped construct Camp Malakole and watched its growth until they sailed for the war theater in May 1942. The generosity of Colonel Bandel and Major Leaf in provid-

ing photographs of the camp is gratefully acknowledged (Addendum V). Colonel Bandel also supplied the highly informative and well written regimental history enclosed in this report (Addendum IV).

APPENDIX III (continued): A Study of the Wartime History of Camp Malakole, 1940-1946

INTRODUCTION

The looming threat of war in the Pacific and its ultimate outbreak on December 7, 1941 had created an extraordniary requirement for additional Hawaiian lands usable for military purposes. Land was urgently needed for the construction of airfields, camps, training and maneuver areas, storage and communication facilities, defensive gun positions, and for a multitude of other miscellaneous purposes.

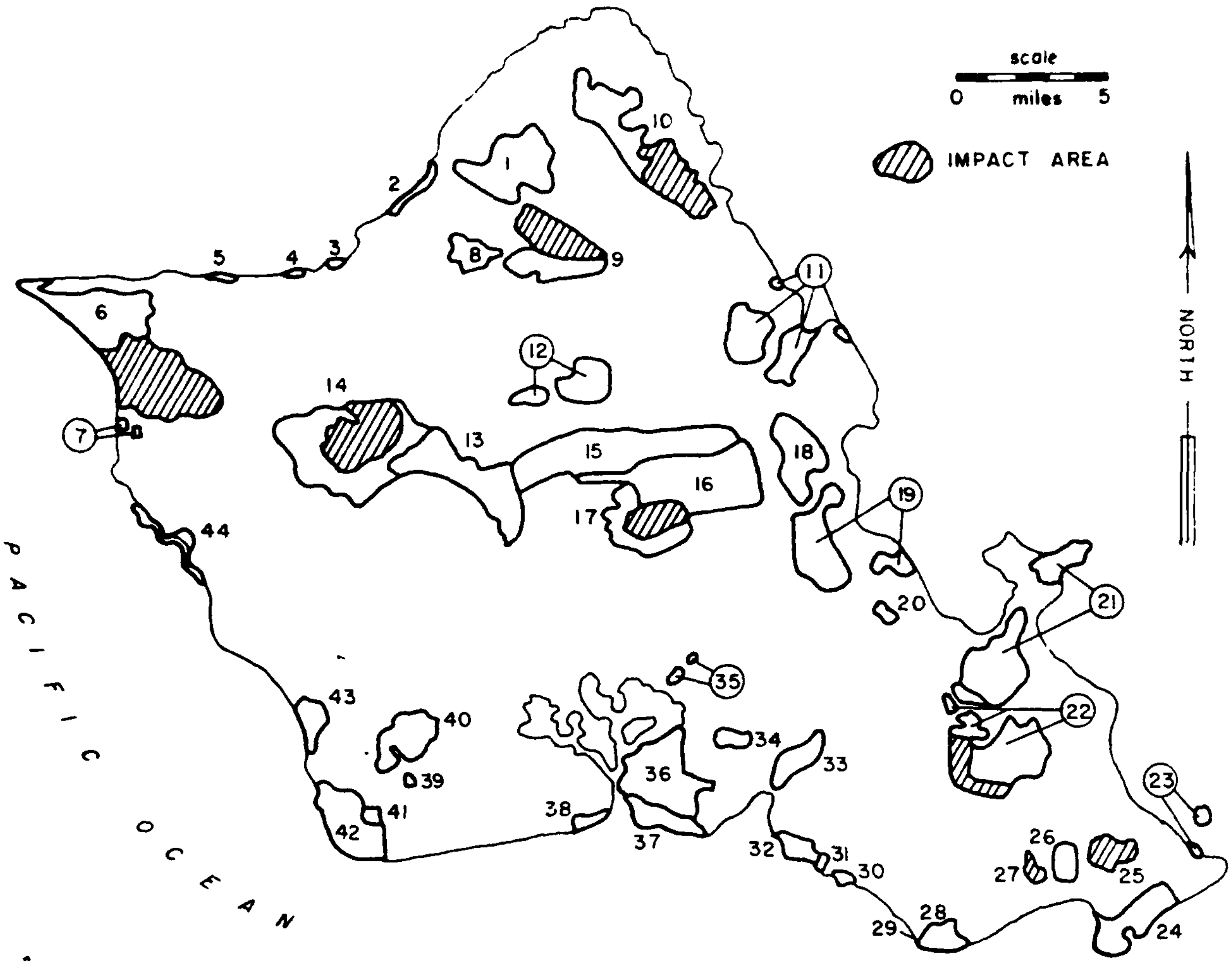
Of all the major islands in the Hawaiian chain, O'ahu was most affected by this situation. At its maximum land usage level around 1944-1945, almost one-third of its suitable land area was being utilized by the Armed Forces for one purpose or another (see Figure 101). The Army's training areas, camps, bases and airfields almost encircled the O'ahu coastline, while the Navy expanded primarily in the Pearl Harbor and Barber's Point Naval Air Station areas. The old Navy Mooring Mast Field at 'Ewa Beach was converted (Navy Day 1948) into an important Marine Corps Air Station. Several chronological events for land negotiations and other related happenings for this period follow:

1937: Emergency Funds of the Federal Government were used to construct about 18 miles of road in the Barber's Point area.

1939: Jurisdiction of the military reservation in the Barber's Point Area is assigned to Commanding General, Hawaiian Service Command, Army Bases (Addleman, n.d.:62).

---- A map of the Ewa Plantation Company dated July 27, 1939 clearly defines the U.S. Army Road extending westward from the Pu'uloa Area and paralleling the coast to its terminus in the vicinity of the Barbers Point Lighthouse. Note that the "Barber's Point Connection" had not been constructed at this time (see Figure 102).

---- During the war additional engineering road construction was accomplished, including the improvement of existing roads and the



1 - PUPUKEA TRAINING AREA
2 - WIAMEA BAY TRAINING AREA
3 - KAIAKA BAY CAMP
4 - PUUIKI TRAINING AREA
5 - MOKULEIA TRAINING AREA
6 - MAKUA TRAINING AREA
7 - MAKUA CAMP SITES
8 - EUCALYPTUS FOREST TRAINING AREA
9 - KAWAILOA TRAINING AREA
10 - KAHUKU TRAINING CAMP AND AREA
11 - UNIT JUNGLE TRAINING CENTER
12 - 13th REPL. DEP. WPNS. TNG. CEN. & AREAS
13 - SCHOFIELD BARRACKS
14 - SCHOFIELD RANGE
15 - EAST RANGE
16 - CENTER COMBAT RANGE
17 - WAIAWA TRAINING AREA
18 - WAIAHOLE TRAINING AREA
19 - HEEIA TRAINING CAMP AND AREA
20 - IOLEKAA TRAINING AREA
21 - FT. HASE TRAINING CAMP AND AREA
22 - PALI TRAINING CAMP AND AREA
23 - WAIMANALO TRAINING CENTER
24 - KOKO HEAD TRAINING CENTER
25 - MARCONI IMPACT AREA
26 - KULIOUOU RANGE
27 - WAILUPE IMPACT AREA
28 - FT. RUGER
29 - DIAMOND HEAD
30 - FT. DE RUSSY
31 - FT. ARMSTRONG
32 - SAND ISLAND
33 - FT. SHAFTER
34 - SALT LAKE RES.
35 - AIEA
36 - HICKAM
37 - FT. KAM
38 - FT WEAVER
39 - FT. BARRETTE
40 - PUU MAKAKILO TRAINING AREA
41 - LITTLE SCHOFIELD
42 - BARBERS POINT TRAINING AREA
43 - KAHE POINT TRAINING AREA
44 - WAIANAE TRAINING AREA

FIGURE 101 ISLAND OF OAHU, TRAINING AREAS CAMPS AND CENTERS, HEADQUARTERS, CENTRAL PACIFIC AREA USAFICPA NO. 5182, DATED JUNE 1944.

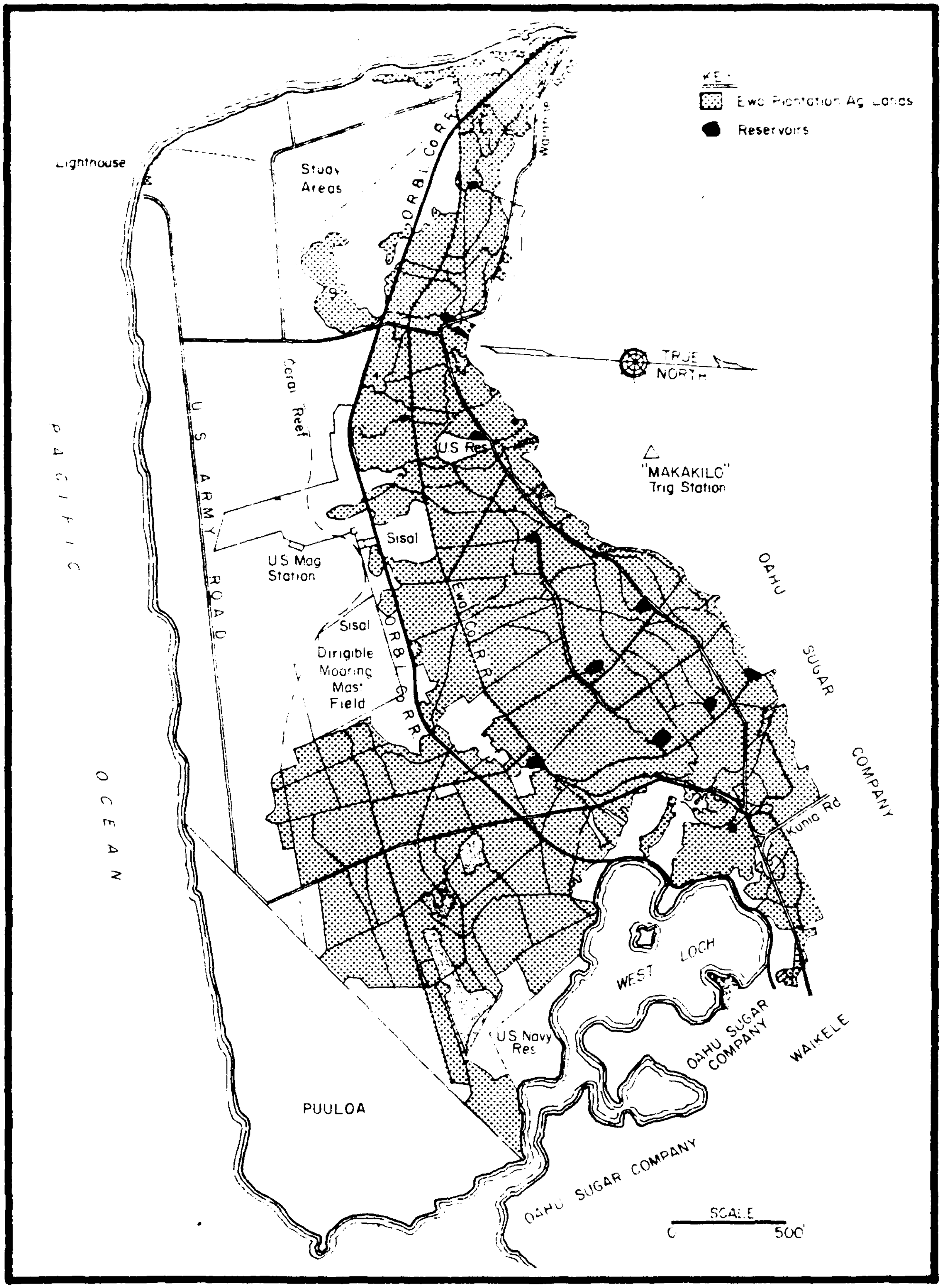


FIGURE 102 EWA PLANTATION COMPANY, DATED JULY 27, 1939

completion of the Barber's Point and 'Ewa Beach connecting road links (see Figure 103).

1940: August 9, the Navy announced plans for the largest air base in the Pacific to be built on 2700 acres at Barber's Point.

---- November 5, the SS WASHINGTON arrived from the Mainland with the first big group of defense workers for Pearl Harbor and Midway and 750 members of the 251st Coast Artillery (Anti-Aircraft) Regiment for service in Hawaii (Allen 1950:391-94).

Land acquisition methods (land for military needs) were based on such variables as previous tenure status, purpose for land use, duration of requirement, and its need for exclusive use. Public lands could be transferred by executive order, or private lands transacted through lease, license, permit, and condemnation. Leases invariable contained a restoration clause. This required the government to return the property in as good condition as when taken over, or pay compensation for damages sustained and not restored.

In summary, the total volume of Hawaiian lands acquired through leasing, licensing, and other nonfee simple arrangements comprised 210,000 acres for Army use, and 118,694 acres for the Navy. During the period from December 1941 to September 1945, the Army's Real Estate Branch executed some 1,500 leases, 1,600 licenses, and 350 permits, with annual lease rentals amounting to nearly four million dollars. At war's end in 1946 the Armed Forces held in fee simple or executive order some 62,058 acres, as compared with 30,924 acres in 1940. By December 1948 the above land total held was reduced to 60,645 acres (Kraemer 1949:8-9). Under the Army's post-war "Roll Back Plan" much of the land occupied by emergency acquisition had been vacated and 750 leases were terminated.

The Camp Malakole Military Reservation, also known as the Honouliuli Military Reservation (Malakole Campsite), is located on the southwest coast of O'ahu, in the 'Ewa District. The camp area, composing 75.016 acres, was once part of the Estate of James Campbell,

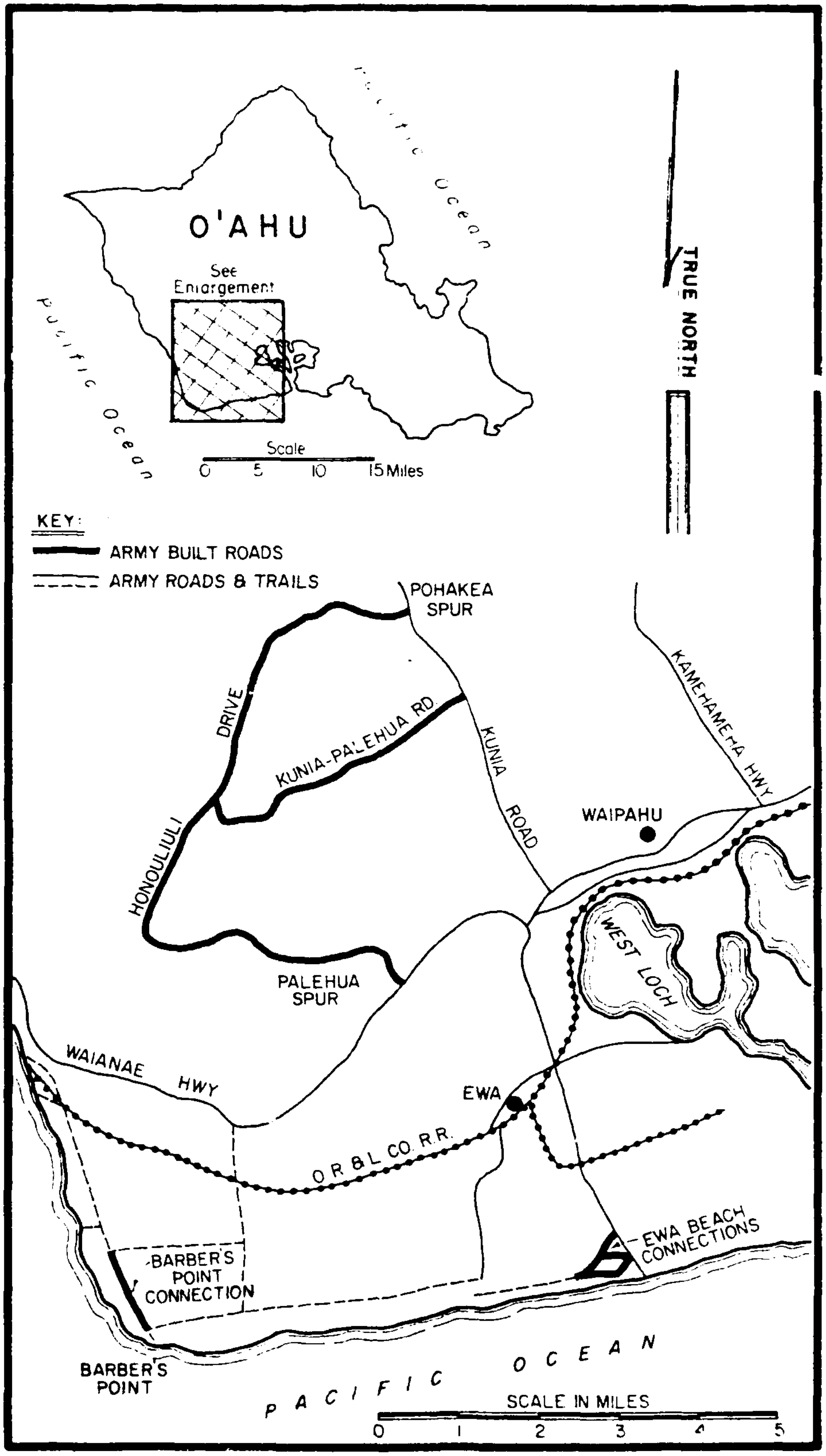


FIGURE 103
PEN AND INK TRACING OF BARBER'S POINT AND PU'UMANAWAHUA ROAD NETS(1945)

the Scotch-Irish emigrant born 1826 in Londonderry, Ireland. When most of his contemporaries considered the land as almost totally worthless, Campbell had the prescience of mind to forsee its potential worth. He acquired vast tracts of land in Honouliuli totaling thousands of acres, most of which remain under lease to the 'Ewa Plantation Company today (Nellist 1925:71-73).

ACQUISITION OF HONOULIULI MILITARY RESERVATION (CAMP MALAKOLE)

At the Prince Jonah Kuhio Kalaniana'ole Federal Building in downtown Honolulu, Room 5124 composes a suite of offices of the Real Estate Branch of the Army Corps of Engineers, based at Fort Shafter. This department is responsible for the negotiation, maintenance, and restoration of the Hawaiian lands acquired for military purposes. In the records section a thick document folder labeled "Honouliuli Military Reservation" was placed at my disposal for study on the morning of November 6, 1980. Extract copies were made for inclusion in this report. The office was also very helpful in providing a copy of Map 122, Land Court Application 1069, which accurately defines the surveyed boundaries, lots and easements of Camp Malakole (see Figure 104). The following series of documents, in whole or part, present much of the history of acquisition, transfer, and disposition of military land parcels in the Honouliuli Military Reservation, Camp Malakole Area.

Subject: Acquisition of Land Near Barber's Point, T.H.
AG 611 1-2-41 (M-D) 3d Ind
War Department, AGO, March 9, 1941
To The Under Secretary of War.

1. The Secretary of War directs that you be informed that there is a sudden necessity for the acquisition of approximately 75.016 acres of land near Barber's Point, T.H., and a right-of-way thereto by exchange for parcels 2, 6, and R-2 on the Fort DeRussy Military Reservation, T.H., as outlned in the accompanying papers and under such terms as are acceptable to the Secretary of War.

J. G. BRECKINRIDGE
Adjutant General

- -

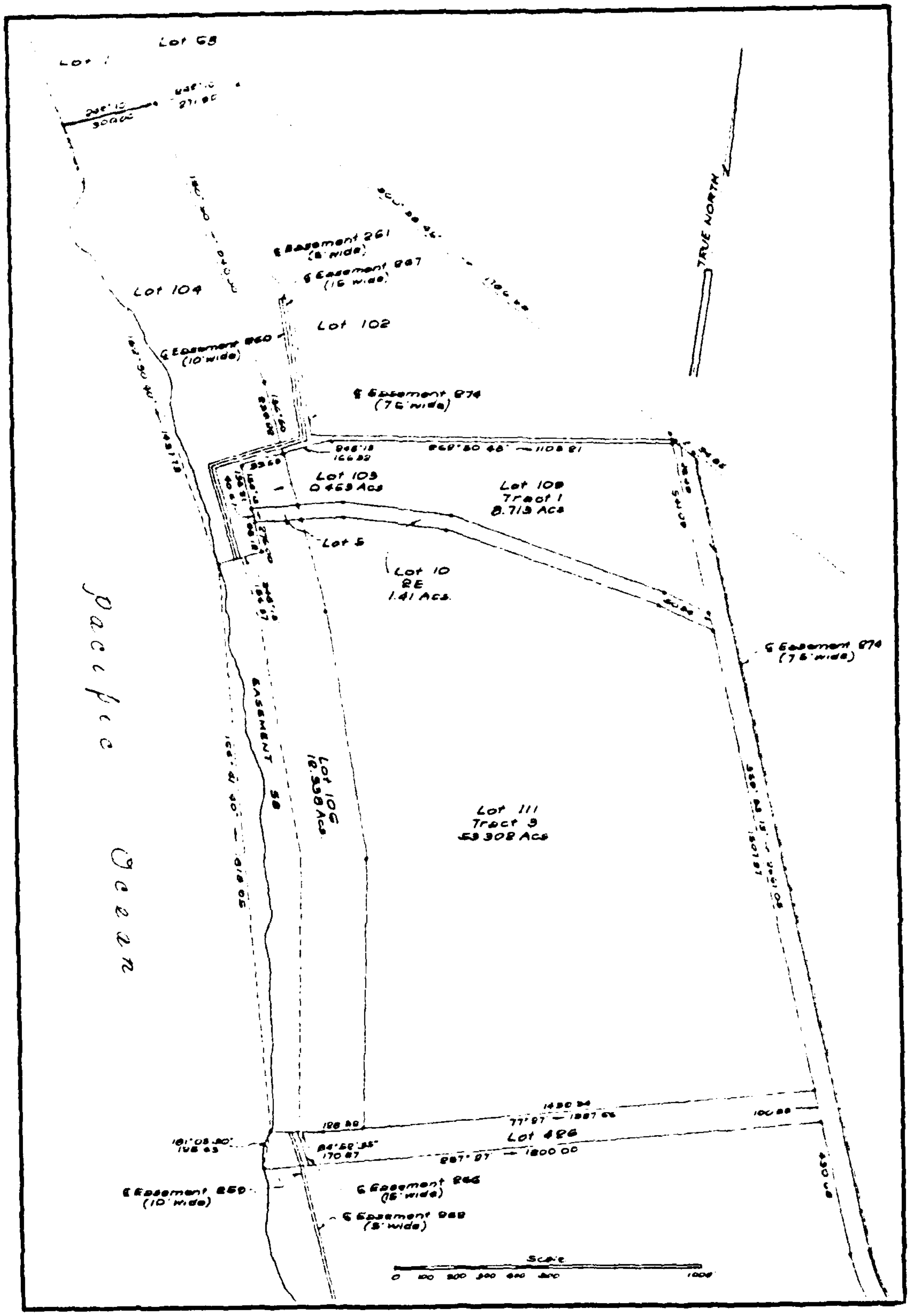


FIGURE 104
MAP 122, LAND COURT APPLICATION 1069

REAL ESTATE HISTORY OF THE HONOULIULI MILITARY RESERVATION

(1) The Honouliuli Military Reservation containing an area of 75.016 acres, more or less, is situated at Honouliuli, District of 'Ewa, Island of O'ahu, Territory of Hawaii. This area was formerly the Malakole Campsite.

(2) This reservation is comprised of four (4) parcels of land, covered by Certificate of Title No 15,790.

(3) This tract of land and a right-of-way thereto was conveyed to the United States of America by deed, dated 11 December 1940, which deed has been entered in the Office of the Assistant Registrar of the Land Court, Bureau of Conveyances, Territory of Hawaii as Document No. 55765, in exchange for certain parcels of land aggregating about 62,219 square feet known as Parcels 2, R-2, and 6, lying and being at Kalia, Waikiki, Honolulu, O'ahu, T.H., comprising portions of the United States Military Reservation of Fort DeRussy. Said lands at Fort DeRusssy were required by the City and County of Honolulu for the improvement and realignment of a road known as the Ala Moana and were conveyed to the Territory of Hawaii by quitclaim deed signed by the Secretary of War 14 December 1942. The deed for the lands at Honouliuli were negotiated by the Territory of Hawaii; deed and certificate of Title were made directly to the United States of America and the consideration was $7,500.00 paid by the City and County of Honolulu to the James Campbell Estate. This exchange of deeds covering the lands referred to was accomplished on 11 January 1943.

(4) Authority for the above transaction is provided in an Act of Congress approved 13 October 1942 (Public Law 742-77th Congress) Entitled "An Act to Authorize the Secretary of War to exchange certain lands of the United States located within the Fort DeRussy Military Reservation, O'ahu, Territory of Hawaii for certain land at Barber's Point, owned by Territory of Hawaii.

Present Area of Honouliuli Military Reservation-----75.016 acres.

- -

DESCRIPTION OF MALAKOLE ANTIMECHANIZED RANGE

All of that certain piece or parcel of land situated at Honouliuli, 'Ewa, O'ahu, Territory of Hawaii, being all of Lot 108 of Land Court Application 1069 and containing an area of 460 acres, more or less.

Malakole Anti-Mechanized Range is located approximately 25 miles from Honolulu in a westerly direction and consists of 460 acres of land, more or less, and is situated immediately west of Barber's Point Lighthouse, immediately adjacent to the Honouliuli Military Reservation and approximately one mile south of the Barber's Point Naval Air Station. It has a sea frontage of approximately 8000 linear feet.

There are two general types of land classification, namely beach frontage composed largely of sand dunes and the balance of tract used prior to occupation by the United States as cattle grazing land.

There has been but little top soil existing on the tract as a whole and it generally existed in non-contiguous patches--but despite this fact the kiawe trees and certain grasses have grown extremely well.

The Malakole Anti-Mechanized Range is the only range of this type on the island and is utilized by a large number of organizations for this type of training. The site is particularly adaptable to this type of range because of the flat terrain and extensive ocean frontage.

This site is under lease to the Army for the duration and six months at an annual rental of $2.50 per acre.

- -

TRANSFER CERTIFICATE OF TITLE NO. 23,017

From Original Certificate No. 15,790, Originally Registered October 23, 1936 in Registration Book 158, Page 357 for the Registry District of the Territory of Hawaii.

This is to Certify that the United States of America is the owner in fee simple of these certain parcels of land situated at Honouliuli, District of 'Ewa, City and County of Honolulu, Territory of Hawaii, described as follows:

LOTS:	103, Area	0.463 acre;
	106, Area	12.538 acres;
	109, Area	8.713 acres; and
	111, Area	53,302 acres

Together with an easement for a right-of-way for road purposes in common with the Trustees under the Will and of the Estate of James Campbell, deceased, their successors, assigns, and tenants, over, across and upon all of Lots 105 and 110, as shown on Map 25, filed in the Office of the Assistant Registrar of the Land Court of the Territory of Hawaii with Land Court Application No. 1069 . . . . Witnessed by the Honorable A. M. Cristy, Judge of the Land Court at Honolulu, City and County of Honolulu, Territory of Hawaii, on 14 December, 1940, at 1045.

[NOTE: This is the Camp Malakole Title Certificate for 75.016 acres of land. See also Figure 102.]

- -

Standard Form 118 Report of Excess Real Property
Honolulu 23-A, Honouliuli Military Reservation
(Camp Malakole) Dated 19 November 1954

[para] 18. The property is roughly rectangular in shape with approximatley 1,853 feet of beach frontage. It is surrounded on the other three sides by pasture land which is capable of further development. The soil is thin and sandy on old coral ledges. The "Other" under [subpara] 10. c above consists of a 1.413-acre easement which divides the fee-owned parcel into 2 tracts and a 0.71-acre easement for a water pipeline.

This property has been screened against the known defense needs of the Department of Defense. The holding agency is disposal agency in accordance with authority delegated under General Services Administration Regulation, Title 2. The Judge Advocate General, Department of the Army, Washington 25, D.C. is custodian of the title papers.

This form is a correction of a report of excess with Holding Agency No. Honolulu 23, dated 4 February 195[illegible]. It was prepared to show an estimated original cost for certain government-constructed improvements which remain in the land; there are portions of a water system and a sewer system, 3 sheds, roads, fences, concrete slabs, foundations, etc., all of which are considered as having neither in-place value nor salvage value. It also shows a cost for the land since a 1.413-acre portion of Fort DeRussy Military Reservation was deed to the City and County of Honolulu and in exchange the City and County of Honolulu paid the Estate of James Campbell $7,500.00 which in turn granted a road easement over 1.413 acres and deed 75.016 acres to the United State of America.

The withdrawal property listed above included 3 sheds, 6' x 6', 9' x 9', and 14' x 18'. The cost to the government of Buildings, Structures, Utilities and miscellaneous facilities:

Total property	$45,289.00
Deeded land, 75.016 acres	7,500.00

[NOTE: No traces of the 3 sheds could be found during a thorough inspection of Camp Malakole conducted on October 30, 1980.]

- -

Miscellaneous documentary extract:

Effective 24 January 1951, it has been determined that two Coast Artillery batteries and Honouliuli Reservation (including Camp Malakole and Barber's Point Military Reservation) are excess to the needs and discharge of responsibilities of the Department of Defense. . . .

Range of possible Uses--Malakole. Approximately 6-acres along the beach are potential beach home sites. The balance is agricultural, principally cattle grazing and piggery sites.

- -

Real Property Report dated 4 February 1952

Honouliuli Military Reservation 16.3 miles west of City of Honolulu.

Camp site listed at 4.41 acres Cost to United States $636,932.80 (License terminated 1 December 1945.)

1.25 acres Anti-Mechanized and AAA Range (License terminated 6 May 1946).

Leased acres 1,989 at Rental $4,972.50.

Range of possible uses: Some of the property is suitable for residential purposes but the majority is only fair pasture land.

Remarks: The land is a roughly rectangular parcel next to the ocean and bounded on three sides by heavily overgrown pasture land. The shore is very rocky and swimming poor."

[Real Property Form (Engr Form 836 dtd 1 Dec 1946)]

- -

REALTY CONTROL FILE SUMMARY AUDIT NO. 7185

Honouliuli Military Reservation in Honolulu County 16.3 miles west of the City of Honolulu.

Officially designated by Hawaiian Department Regulation 75.10 dated 4-16-41. Type Army - Military Purpose Camp and Range.

Acquisition data	Cost	Rental
75.02 Fee		
5.66 License (2)		
2.12 Easement		
2449.00 Lease		
2531.80 Total acres	*	$6,122.50

Disposal data		Rental
5.66 License (2)		
0.71 Easement		
2449.00 Lease		
2455.37 Total acres	**	$6,122.50

Net	
75.02	Fee
1.41	Easement
76.43	Total acres

* 75.02 acres, Fee and 1.41 acres Easement acquired in exchange for 1.43 acres Fee, of Fort DeRussy, cost $1707.65, and an additional $7,500.00 paid by the City and County of Honolulu, costs not included above.

**	42.90 Acres,	Lease,	terminated	31 January 1945
	876.86 Acres,	Lease,	terminated	30 June 1945
	4.41 Acres,	Lic (1)	terminated	1 December 1945
	1.25 Acres,	Lic (1)	terminated	6 May 1946
	1069.24 Acres,	Lease,	terminated	30 April 1947

0.71 of an acre Easement conveyed to the Trustees under the Will and of the Estate of James Campbell, by Quitclaim Deed dated 17 August 1955.
[Engr Form 1603]

- -

WITHDRAWAL OF HONOULIULI MILITARY RESERVATION (CAMP MALAKOLE) FROM EXCESS STATUS

LOG/N1 31222

Subject Withdrawal Camp Malakole from Excess Status

TO: Chief of Engineers

From: DCS LOG Date: 17 June 1956

1. Reference ltr GPENG 602, dated 28 June 1950 Subj: Disposition of Camp Malakole, Barber's Point Military Reservation and Anti-Mechanized Range.

2. DCS LOG approves withdrawal from excess status Camp Malakole.

3. . . . .

By direction of the Deputy Chief of Staff, Logistics

/s/ Harry F. Kirkpatrick

Col. G.S.
Deputy Chief, Real Property Division

[NOTE: At that time, the Camp Malakole property was required for a Surface-to-Air Missile Site (NIKE). This information has long since been declassified.]

CAMP MALAKOLE HISTORY

Other documentary sources confirm that Camp Malakole was officially established by Headquarters, Hawaiian Department General Order No. 1 dated 9 January 1941 (AP&SC, n.d.:163-164). The author who coined the name Malakole is unknown, however, it can be simply translated from two Hawaiian words: mālā (with a macron over the last letter to indicate vowel length or stress) means garden, plantation, or cultivated field; and kole means red (Pukui and Elbert 1975:149,213). Although the camp site is located on a rough and barren limestone terrain generally devoid of contiguous patches of soil, its proximity to the heavily cultivated, red volcanic soils of Ewa Plantation's cane fields must have strongly influenced the choice of names.

An early function of the camp was to maintain a defensive gun and firing position sector for a Coast Artillery (Anti-Aircraft) Regiment. Destiny selected a California National Guard organization which mobilized on September 16, 1940 and thereby commenced its own historical odyssey. This unit was the 251st Coast Artillery (Anti-Aircraft) Regiment, which would have a singular distinction of being the first National Guard Unit ever to be ordered outside the Continental United States in peace time. The understrength Regiment was composed of 1st Battalion (75mm) located at San Diego, and the 2d Battalion (37mm) based at Long Beach, California.

With a peace time strength of 1,200 officers and men, it was divided into two contingents for shipboard travel. The first echelon embarked and sailed for Hawaii on October 31, 1940 as first class passengers aboard the commercial luxury liner, SS WASHINGTON. The second contingent, enjoying considerably less seagoing luxury, followed up three weeks later aboard the USS LEONARD WOOD, an Army Transport Service troopship. It departed the Mainland on November 23, 1940. Upon their arrival in Honolulu the Regiment was regrouped and assigned to two months of essential refresher training at Fort Ruger and Fort Shafter facilities. From there it was moved to its permanent location, designated by the Hawaiian Department, at Camp

Malakole. Once in the area it began a daily ritual of spending half a day on the firing line (setting up defensive gun positions), and the balance of the day constructing its own camp.

According to an article that appeared in the Honolulu Advertiser on January 21, 1941 under the title of "The Saga of the 251st C.A.", the unit had already accumulated a lengthy travel log since its mobilization and was interested in adding on to it. One paragraph is quoted:

> During the first part of November (1940) the Regiment started on the voyage to Hawaii. On the 17th of November the last of the Regiment left its native soil by way of San Pedro and added 2345 miles by the time it arrived at Fort Shafter on O'ahu. The next stop was a short move to its new home in a kiawe grove 25 miles from Fort Shafter. Here the men fell to with a will to clear away the tenacious kiawe, or algaroba, as it was known to these Californians. The men are building their own quarters amid the hardships of inadequate toilet and water facilities with little complaint. . . .

During its early training preparations on O'ahu the Regiment received a large quota of selective service replacements, thereby bringing it to a full wartime strength of 2,400 men. As the potential for impending conflict became more apparent during the remainder of 1941, the Regiment was frequently ordered on full alert deployments in the field. With its mobile, vehicle-equipped gun batteries and units of ammunition, it was assigned various defensive positions around the west shore of Pearl Harbor and the outer perimeter of Schofield Barracks to provide a coordinated anti-aircraft defense with the Navy and other Army units. However, on December 7, 1941 all carefully prepared plans and procedures were of no avail. The Regiment was in quarters at Camp Malakole having just returned from a week-long full island alert elsewhere, and ammunition had been returned to storage bunkers. Nevertheless, its guns did participate during the attack by setting up a hasty defense and effectively driving off the Japanese dive bombers attacking the Camp Malakole base. According to an eye witness at the scene, Major John M. Leaf, U.S. Army (Ret), "the Regiment was credited with destroying at least two of the attacking aircraft, one crashing within the camp boundary and the other toward the Pearl Harbor area."

During May 1942, the Regiment, originally scheduled for the defense of the Philippine Islands, left Hawaii for further duty in the Pacific. It sailed from Honolulu in a two-ship convoy aboard the MORMAC STAR and MORMAC SEA (converted merchant ships) bound for Suva Harbor at Viti Levu, Fiji Islands. There it established the anti-aircraft defense for a critical airfield, its heavy weapons camouflaged under thatched Fijian huts. From Fiji the Regiment later participated in campaigns on Guadalcanal (1943), Bougainville (1944), and Luzon, in the Philippines campaign (1944-1945). (See the Addendum in this Appendix for correspondence with Major Robert MacDonald, Ret.). Major Leaf also states that "his Regiment was relieved on O'ahu in May 1942 by an all-black regiment commanded by a Colonel Hooper. They were thereafter referred to as 'Colonel Hooper's Troopers'."

Camp Malakole continued to function as an important base camp site after the departure of its first tenants in 1942. Weapons training schools were established and maintained for the Mark-I and Mark-II gunnery training devices. On adjoining acreage, leased for the duration and six months from the Campbell Estate, was the Honouliuli Military Reservation where live-firing ranges for anti-aircraft and anti-mechanized tank-infantry training was conducted. When combat techniques, absorbed in Pacific operations through the Marianas Campaigns (Guam, Saipan and Tinian), emphasized the importance of anti-aircraft weapons in a field artillery role, the area was enlarged as an anti-aircraft training center. A mile-long, standard guage (4'8½") railroad track designed for a speed of 50 miles-per-hour was constructed by the Army Corps of Engineers to provide essential target mobility.

By August 1943 the tempo of the Pacific war had shifted from a local Hawaiian defense posture into a gathering momentum of offensive operations in the forward areas. Camp Malakole was assigned to the operational control of the Army Port and Service Command (AP&SC) as were all other Army camps and bases on O'ahu. Under the command of Brigadier General Roy E. Blount, a career cavalry officer, this organization was activated on August 10, 1943, and quickly developed into a vital transportation and service establishment for the Central Pacific Area. With its headquarters on Sand Island during the remaining 34 months of the war it transformed the Honolulu Port into one of the world's most active for processing war cargo tonnage.

Also subject to ever-increasing needs and requirements of the war, Camp Malakole became an important base camp during this period and was assigned additional functions and responsibilities. It was utilized as a staging and billeting center for some of the thousands of transient/replacement personnel preparing to enter the theater of operations. With these troops isolated far from Honolulu's city lights and abundant temptations, the camp was ideally situated for such a purpose. Combat-bound troops made maximum use of its rugged limestone terrain, and sharpened their infantry and supporting skills in small unit training exercises. This acitivity may still be evidenced by finding occasional traces of military artifacts and the disturbed remains of limestone rubble in the project area. The latter was utilized to erect hasty foxhole parapets on a surface where digging was prohibitive. In several cases it is believed that efforts were made to enlarge or improve upon the walls of the cultural habitation sites under study.

Although Camp Malakole was designated to support a population of 2,000 men, it is considered that a larger overflow of troops staging there, and in the Wai'anae sub-camps, was billeted in the Army's standard pyramidal canvas tents. The supporting forces of permanently based personnel (administrative, training, utilities, and supply echelons) probably occupied most of the barracks structures. Also, while the camp site didn't have the transient capacity of larger O'ahu staging centers nearer the Honolulu Port, records of the Army Port and Service Command report that a total of 43,350 troops, Army and Marine, were billeted and staged through Camp Malakole. This equates to an average monthly turnover of 1,155 troops passing through the camp during the final 32 months of the war (AP&SC:163-164).

On May 27, 1944, Headquarters, Central Pacific Area (HCPA) issued General Order No. 165, designating certain camps and training areas as subposts of more firmly established posts and camps already assigned to Army Port and Service Command. To Camp Malakole was assigned the supervisory responsibility of general maintenance and logistic support for the following sub-camps: Wai'anae Amphibious Training Center, Makua Area, Kahe Point Training Area, Maile Landing Beach, and Little Schofield Camp. The maintenance problems attendant to these areas (water, sewage, billeting, food preparation, training devices, etc.) was greatly increased by the fact they were used mainly by transient personnel for short periods of time only. A housekeeping force had to be provided for each location.

As already mentioned, Camp Malakole also served as an important gunnery schools training center throughout the war. A special installation for the Mark-I gunnery school was constructed to enhance this program. For a background descrption of the installation, the following paragraph is quoted from the Army Engineer History (Vol. I:413):

> Late in 1942 the Army Air Crops realized the necessity for training facilities here in the theater of operations as well as the Mainland due to the fact that men relieved of duty for periods of time often required refresher training courses, which at that time required them to return to the United States to existing training centers. "Mark-I" and "Mark-II" gunnery trainers were procured, and this office was called upon to provide suitable housing for them at the earliest practicable date. The "Mark-I" Assembly (Camp Malakole, Work Order 600.118-XB-651, Dwgs. 181/83, 79, 81) required a specially shaped building consisting of one long, narrow high room for the special screen and gun equipment used in the instruction, a small projection room and a room to house air-conditioning equipment so as to be able to carry on instruction during black out hours. . . .

Moveable Target Track

Briefly mentioned earlier, another important feature of gunnery training facilities at the Barber's Point Training Area was a specialized track for moveable targets, also constructed by the Army Corps of Engineers. Extending a full mile in lateral target width and using a standard gauge 4'8½" between rails for improved sled stability, the target vehicle was designed to move at surface speeds up to fifty miles-per-hour (Engineer History, Vol. II:482). Both the track and vehicle were in defilade for protection from gunfire damage. Only the moving silhouetted targets were visible to the gun crews. The firing range impact area was located to seaward. Range safety regulations were carefully observed at all times. This range facility provided the critically needed live-firing experience to the gunners and gun crews of various caliber weapons.

While no specific information is yet available, it is considered that the moveable target facility was a component of the Honouliuli Military Reservation training center. This complex comprised the Anti-Mechanized Range and Anti-Aircraft Range which also employed live-firing at movaeble targets. Accordingly, with emphasis being focused on the great need for safety precautions, it is believed that the high volume of firing was carefully coordinated and scheduled from a centralized range operations department at Camp Malakole or nearer the range area.

Supply Distribution Point

As a firmly established camp site in the 'Ewa area, Camp Malakole was further assigned as an Area Supply Distribution Point and Sub-depot for Reserve Supply Stocks. To fill the need for a more efficient method for the dispersion and distribution of field stocks, or military classes of supply, the Army Quartermaster Corps devised a zonal system establishing ten major supply areas on O'ahu, each with centrally located supply points responsible for its own zone of distribution. These points consolidated and submitted to the Hawaiian Depot bulk requisitions for units within their boundaries. The supplies were then received and redistributed to their recipients. It was an effective system for Camp Malakole to accommodate the needs of its Wai'anae sub-campus and other training center tenants.

In addition to this supply distribution arrangement, Camp Malakole became an important sub-depot for the storage and logistics control of reserve stocks of specifically assigned supply items indispensable to field troops. In Area 9, for example, Schofield Barracks with larger warehouses and cold storage facilities, specialized in the reserve storage of food supplies. Camp Malakole became the sub-depot for reserve stocks of clothing, and general supplies (Stauffer, 1956:39).

DESIGN AND CONSTRUCTION

As a former member of the 251st Coast Artillery (AA) Regiment, Major John M. Leaf, USA (Ret) was an eye witness to, and actively participated in the 1941 construction of Camp Malakole. He states that "at the beginning, three or four Engineers with blue prints were assigned to the project for technical assistance and liaison. It was the Regimental troops who turned to with willingness and esprit to serve as carpenters, plumbers, concrete finishers, and road builders, to construct the camp from the ground up". Not that they were unqualified for the assignment. As recent weekend warriors called to arms the majority of them probably possessed construction skills in various occupational specialities that helped turn military camp construction into a routine matter.

In any case, the neat and well-ordered camp design was in consonance with the Army Corps of Engineer's new wartime policy concerning the building of camps in Hawaii. A need for uniformity and strict economy of materials was subject to the variable facilities and requirements, each dependent on location, terrain, and probable usage (Engr History, Vol. II:369). For example, on flat limestone terrain like that at Honouliuli, a camp was planned with one or more straight roads, with administrative units centrally located and other units grouped on both sides. The motor transport area would be near the entrance and downwind to reduce air pollution and dust problems. Latrines, shower buildings, and messing facilities would be located along the main road to augment access and service. Before and during the construction phase its prospective occupants were likely to be bivouacked nearby in straight, orderly street rows of strong-backed (reinforced) pyramidal canvas tents with wooden flooring. One such tent will comfortably billet eight (8) men, along with folding canvas cots, personal clothing and equipment. If the above scenario has a familiar ring by now, it could be used to describe Camp Malakole at its inception.

Subject to early wartime requirements for mass camp construction in Hawaii, the Army Engineers designed new types of standardized, multi-purpose structures utilizing up-dated techniques of p efabricated assembly. This was accomplished by assembling unit incr ients at a number of specialized mills. Strong emphasis was place on speed of construction combined with strict economy in the expenditure of critical materials and labor. In January 1942, a "demountable" type building 16'8" wide built in 10'0" lengths (Engr. History, Vol II:369) was designed for barracks, supply, recreation, administration, and other multi-purpose uses. To conserve scarce lumber a substitute material was found in "canec". It was made from bagasse, a compressed fibrous waste byproduct of sugarcane. This fiberboard was used for inside wall and ceiling sheathing. The "demountable" model was later replaced with two improved, standard-size building units--16'0" and 20'0" in width, with 10'0" lengths (Engr History, Vol II:369). These were of a more serviceable design and meant for extended service at projects like Malakole.

Also carefully considered and drawn into the construction blueprints were the necessary utilities plans providing a water system and sewage installation. "With every project in which the housing or stationing of men were concerned, of primary importance was providing potable water, water for fire protection and the disposal of sewage. At Camp Malakole a new, permanent type installation was authorized for a design population of 2,000 men." (Engr History Vol. II:618)

On January 18, 1943, the Office of the Military Governor (OMG) ordered the chlorinating of Honolulu's water supply as a precautionary measure. In compliance with OMG General Order No. 154 water chlorination installations were scheduled for most construction sites. For unknown reasons, a work order was not scheduled for Camp Malakole, then designated as Installation #28 (Engr History Vol. I:361).

Camps with design populations greater than Camp Malakole were built for Regimental Combat Team (RCT) sized units, such as the Honouliuli Military Reservation at Barber's Point. Constructed on similar flat terrain at an approximate cost of $38,000, it was designed for 5,600 men to man the following RCT units: 1--Special Battalion, 1--Engineer Comb. Battalion, 3--Infantry Battalions, 1-Field Artillery Battalion, and 1--Regimental Headquarters Unit. No other information has been found fitting this descripton of a reinforced infantry regiment being in the area. However, the Meeker report mentions elements of the 98th Infantry Division and other small troop units manning beach positions between Camp Malakole and the Barber's Point Lighthouse (Meeker 1980:1).

TRANSPORTATION

The primary means of access to Camp Malakole during the war was by truck and other motor vehicles. The camp was never connected to the island railroad system. In 1941 the minimum capacity, poorly maintained road net of the 'Ewa District was almost incapable of coping with the heavy buildup of military traffic. Improvements were necessary to transport thousands of troops, equipment and cargo tonnages to camps, warehouses, and depots. The Army Corps of Engineers helped reduce the congesting bottleneck by implementing a road construction program. This culminated in opening up 240 miles of roads, both new and improved (Allen 1950:221-222). In addition to this road program, the Engineers also constructed 48 miles of access railroads and spur lines to principal supply warehouses and depots on Oahu. These were linked directly to the Oahu Railway and Land Company (OR&L) line, and when necessary to sugar plantation tracks. A heavy dependence was laid on rail systems due to the acute shortage and rationing of motor fuels for the war effort.

Near one of the habitation sites in the study area, mauka of Malakole Road, has been found the faint outlines of a slightly curved and elevated railbed that utilized compacted limestone rubble for track ballast. Associated artifacts in the vicinity include pieces of rough-sawn kiawe wood cross ties and several miscellaneous lengths of heavily corroded steel rails. The rails are of lightweight capacity typical for plantation use, and appear to be in the 20 to 25 pound category. Army and OR& L tracks were high-capacity 60 pound rails, whereas sugar plantation tracks were designed for lighter loads, using rails ranging from 20 to 45 pounds (Engr History, Vol. II:481-483).

With reference to the 'Ewa Plantation Map of July 1939 (refer to Figure 102) it may be theorized that these railbed remnants were a section of a permanent type plantation track connected to Field No. 9 which appears to extend out and downward like a swollen appendage from the other plantation fields. This field also points in a general southwest direction toward the study area. To support this theory, the 'Ewa Plantation Company railway system formed a large and complex network of trackage, including thirty miles of rock-ballasted permanent track, and 12 to 15 miles of portable trackage for transient field work. The latter were prefabricated 15-foot sections of portable (18-20 pound) track with cross ties attached, and were used in cane harvesting operations by being moved from one field to another. Its manageable portability required no reinforced or ballasted roadbed--only a manual leveling of the surface through cane rows by track-laying crews. So quickly could this portable track laying and harvesting be accomplished that it was possible to enter a cane field in the morning and get the cane out the same night (Conde 1973:280-283).

Cattleguard

Near the southern fence-line boundary of Camp Malakole and the adjoining Chevron Refinery, a section of the heavily pot-holed, macadamized surface of Malakole Road is bisected by a number of closely paralleled rail tracks still firmly imbedded in the road surface. This feature is likely to be a "cattleguard" or a restrictive device for livestock which is still widely used on large western cattle ranches and other public grazing lands. Each end of the rail cluster is securely anchored to a boundary fence line on either side of the obstruction. Cattle and other livestock being sensitive to its irregular footing are deterred from straying out through open gates or roads onto public highways. Since that area of the Campbell Estate, south and southwest of 'Ewa Plantation, was once used for cattle grazing, the above conclusion seems justified, and similar devices may still be found at other egress points.

CAMP LANDSCAPING

Basically, landscape gardening is the simple planting and cultivation of trees, shrubs, grasses and other ornamental plants in such a manner as to please the aesthetic eye. This achievement was accomplished with considerable success and some publicity at Camp Malakole. Most of the work and horitcultural "know how" was contributed by a handful of volunteering, green-thumbed members of the camp Medical Detachment. During the camp construction, one Staff Sergeant Maliuski and his assistants enlisted the support of many Honolulu and O'ahu plant lovers and their resources. Landscaping came into vogue at Camp Malakole as the arranging of tropical ornamentals and grasses around the more prominent camp installations helped dress up its appearance and improve the troop morale. A tree-planting ceremony was held. In 1943 the Army Port and Service Command organized a Horticultural Branch to provide the landscaping means for all military posts and camps on O'ahu.

A research of newspaper clippings and microfilm at several libraries produced these three trendy items for local and home town consumption:

a. Honolulu Advertiser item dated September 1, 1941

"Malakole Medical Men make Unmatched Record, by Corporal Jack Hill"

This is the caption of a 3-column, 3-inch picture showing two soldiers with a lawn rake and lawn mower working in a kiawe-shaded area in front of what may be the Camp Dispensary. In the near background is a typical wartime, street intersection signpost--pointing to "California" and "San Diego Avenues". A third arm reads "2,260 miles to San Diego".

b. Honolulu Avertiser item, September 17, 1941
A picture and caption only reads:

> "Tug-of-War Contest at a Camp Malakole Party during the Induction Day celebrations"

c. Honolulu Advertiser item, September 24, 1941

Barren Camp at Malakole Now a Flourishing Garden

The 251st Coast Artillery, mostly Californians, moved into Malakole about 9-24-40 [sic] where they found an "algaroba-infested coral plain." A thorny jungle, they planned a "Garden in the Making" by landscaping the camp. Hauling in quantities of top-soil they planted grass around some buildings and more than sixty-five varieties of plants, both common and rare, including hibiscus species, fish-tail palm, orchids, anthurium, ape or elephant's ear, and many others. Honolulu donators sympathetic to their cause included Mesdames E.E. Black, Charles T. Wilder, D.L. Crawford, and S.H. Littel--all of the Outdoor Circle organization. Other contributors were Mrs. Wayne Damon, Madalene Dower, and Mr. John Cummings of the City/County Parks Department; also, the University of Hawaii at Manoa, the U.S. Forest Service, O'ahu Prison, Fort Shafter and Fort Armstrong.

A tree planting ceremony was held to commemorate the occasion. Staff Sergeant Vlidec Maliuski and three other medics, all former gardeners or landscapers in private life, were responsible for completing the work. Some plants were invaded by cutter wasps and Japanese beetles but brought under control.

CAMP MALAKOLE TODAY

After nearly four decades of arid climatic weathering and abandonment, the majority of Camp Malakole's man-made characteristics have been either overgrown by nature or disintegrated away. Through the dense thickets of kiawe trees, weeds, vines and desiccated grasses only the skeletal grey concrete traces of its former camp pattern and usage are still visible. In the vicinity of its narrow, nondescript gateway off Malakole Road, a series of heavy coral boulders connected to chained railroad irons serve as a semi-barricade. This single entrance opens to a frequently used macadam road extending about 300 yards to seaward where it comes to a stop at a coral road junction forming a T-intersection. What was once a broad arterial thoroughfare into the camp is now reduced to a narrowed lane, encroached upon by kiawe trees and other plant growth. The shoulders of the road are nearly obscured. Low concrete and masonry rock walls, their crumbling outlines paralleling each side, give a dimensional concept of its original width and capacity.

The immediate camp area on either side most likely comprised the camp headquarters, its supporting echelons and other specialized installations. There remains everywhere the ubiquitous man-made concrete artifacts where individual structures once stood erect. Judged by their scarcity, only more specialized buildings used a full concrete foundation slab. These sites are noticeably clear of vegetation and are partially covered with years of accumulated leaf-mould. Other building sites are also easy to identify by the neatly aligned formations of concrete foundation blocks. Off to the right, near what was once the first street intersection, stands a massive inclined ramp foundation with a large paved area surrounding it. This was the camp theater. Adjacent to it is the motor transport area, conspicuous for its heavy capacity, drive-up grease and maintenance rack.

Elsewhere throughout the camp are heavy concrete blocks that provided the water and sewage system. In the camp's outer perimeter there remains standing in uniform dispersion the slender concrete pedestals, or gun mount bases, that supported the fifty caliber anti-aircraft machine guns.

Of particular interest was a search made for residual traces, if any, of introduced plant species and their condition of survival since the 1941 landscaping project. Most of them perished in the hostile environment without water and care. Others may have been taken up and transplanted elsewhere before the camp was closed. There still survives however, a number of hardy species deserving of the following comments. The majority are almost centrally located around the foundations on the south side of the main road extending to the T-intersection. This section was apparently more carefully landscaped than elsewhere.

Near the camp entrance, choked in creeper vine and kiawe (Prosopis pallida) stands a single 20' tall, blooming tree-shrub the common red hibiscus (Hibiscus rosa-sinensis). Nearby, a medium-sized (20') umbrella or octopus tree (Brassaia actinophylla) lies up-rooted and horizontal. It continues to foliate and thrive through an umbilical fringe of tenacious roots. In the vicinity of what must have been the Camp Dispensary, a crumbling enclosure of gracefully curved curb sills contain the remnants of a garden. Within it, and bulging out through the masonry, are a cluster of giant century plants (Agave americana). Close by, a small grove of milo trees (Thespesia populnea) and clumps of the poisonous be-still shrubs or yellow oleander (Thevetia peruviana) are to be seen. In the distance a huge kiawe tree is being smothered by an infestation of the climbing night-blooming cereus (Hylocereus undatus). A member of the cactus family, it is also known by its popular Hawaiian name Panini o ka Punahou, so named for its beautiful rock wall presentation at Punahou School. In the same camp area, a single, stunted coconut tree (Cocos nucifera) with a small cluster of immature nuts, stands off by itself in a hostile environment. Throughout the remainder of the camp, the thickets of kiawe and koa haole (Leucaena glauca), the common weed of the Mimosa family, dominates the plant growth pattern. Milo trees grow in scattered, indiscriminate clumps, as do the yellow be-still tree and its reddish-gold cousin (Thevetia peruviana var. aurantiaca). The botanical binomials listed in this paragraph are referenced in Marie C. Neal's book "In Gardens of Hawaii" (1965).

The remainder of the camp area was quite unremarkable. What was once a thriving military community of men, buildings, and equipment is a fading part of history, and the camp has returned almost completely to its natural wilderness state. A tenuous network of surviving coral-based roads still provide a good access to the beach area. These roads appear to be kept usable by the day-to-day traffic of kiawe wood cutters and to other curious visitors, some who conveniently dump their loads of trash and litter into roadside niches and thereby contribute to the cultural middens of the future.

In conclusion, a topographical view of Camp Malakole and the surrounding area may be seen in the last map in this report. Figure 105 is an extract from the Army Corps of Engineers at Fort Shafter Terrain Map, Barber's Point Quadrangle, 1943. It purports to represent the Malakole Road network and shows a faintly visible diagram of the camp's basic road pattern. The paralleled uniformity of the road grid lines clearly delineate the squares and rectangles that contained the installations and other real property development. Noted in Figure 103 is the prominent Barber's Point Connection extending southward from Malakole Road to the vicinity of the Barber's Point Lighthouse. A more recent, undated map of Barber's Point and Vicinity shades in the Project Survey Area as related with the Camp Malakole Military Reservation. It may be seen that the construction of the Standard Oil Refinery and other developments in the Campbell Industrial Park have eliminated all traces of the road network south of Malakole Road.

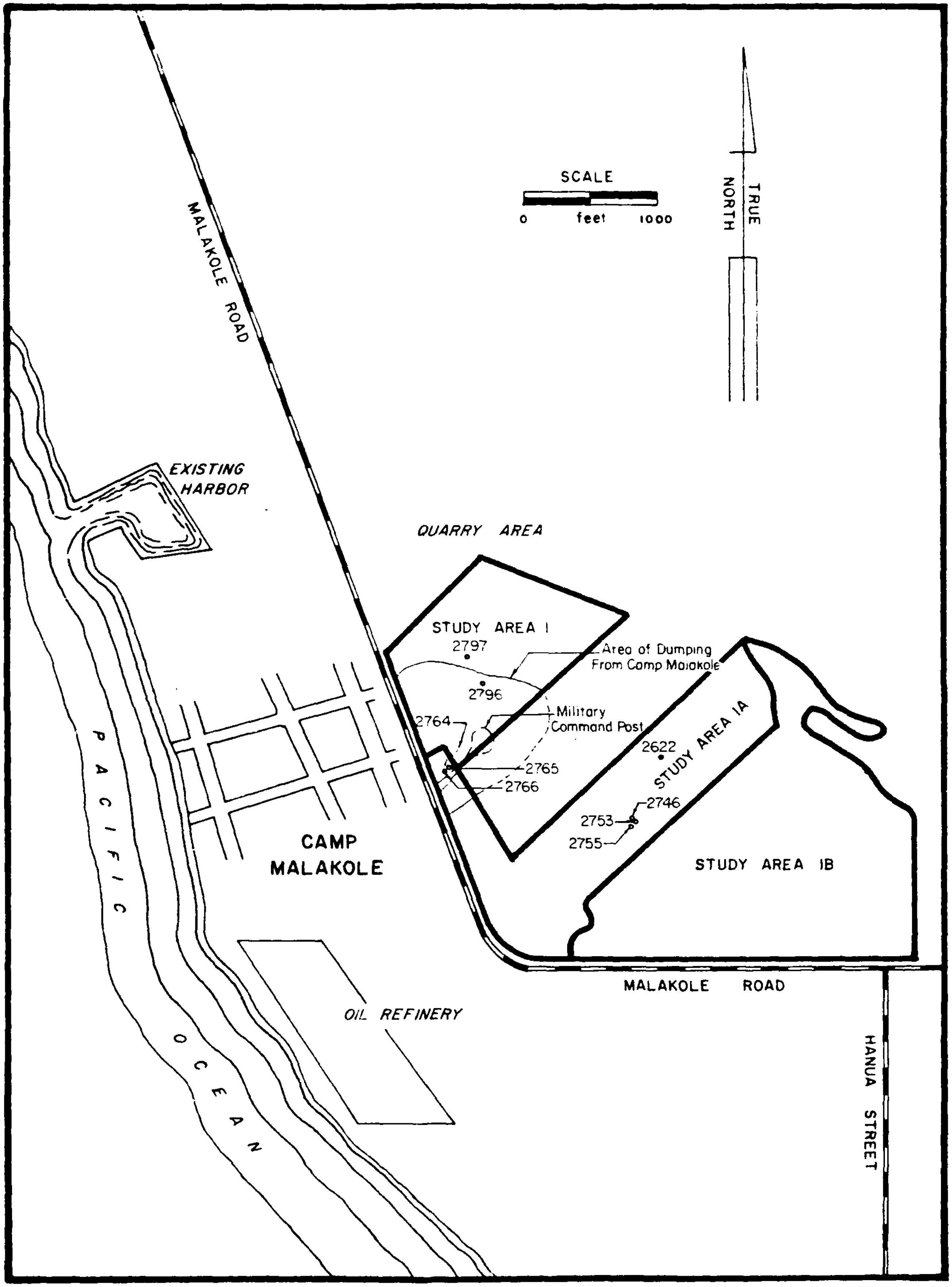


FIGURE 105 PLAN VIEW OF CAMP MALAKOLE COMPILED FROM HAWAII TERRAIN MAP 1943; OTHER FEATURES ADDED.

ADDENDUM I

[Letter to Major Robert Macdonald, dated November 16, 1980]

Dear Major Macdonald

In the Reunions page of the Retired Officer Magazine of October 1980 I noticed with more than considerable interest your approaching organizational get-together on December 6, 1980 that will commemorate the reunion of the 251st Coast Artillery (Anti-Aircraft) Regiment of World War II.

To further explain, I am a retired Marine Officer (since 1968), a recent University of Hawaii Major in Anthropology, and presently employed with the firm, Archaeological Research Center Hawaii, Inc. I am presently working in personal research on the history of Camp Malakole (Old Camp "Melancholy") that was formerly located in the Barber's Point area of O'ahu during World War II. This report will be furnished through my firm to the Army Corps of Engineers here in Hawaii, at their request.

By various military documentary sources I have learned something of your wartime organizational history. In brief, the 251st CA (AA) Regt of the California National Guard was the first NG unit to be mobilized in World War II. The regiment arrived in O'ahu, T.H., in November, 1940, aboard the USS Washington. The Regimental Headquarters plus two battalions and a medical detachment were quickly assigned to the Barber's Point beach defense sector, and were subsequently billeted at Camp Malakole where they remained and served throughout the war to its conclusion.

I realize these are very generalized factors and possible to be misinformed in some respects as to their accuracy. The purpose of this letter to you, Major Macdonald, is that I urgently need your help in a worthy cause to increase our information on your organizational history, and hopefully with any available copies of maps, sketches or pictures of the Camp layout, ranging from the early pyramidal tent phase in the kiawe thickets to the new-style prefabricated and mass-produced multiple-purpose unit structures designed by the Corps of Engineers. During your reunion, or even prior thereto, may I also ask of you to please solicit from your many retired comrades any additional information they may be aware of and are able to recall their long-ago experiences. I am particularly interested in eye-witness accounts of Camp Malakole and its day to day operational themes, no matter how insignificant they may seem, and if desired, I will be more than happy to give individual name credit in my report, or exclude it if the individual so desires.

The following is only a random listing of some of the topics I am hoping for assistance and answers:

1. What was the date of arrival on O'ahu in November 1940?

2. What type of ship was the USS Washington? Was it an Army or Navy transport or a Navy combatant cruiser or battleship?
3. On what date was the 251st CA Regt and medical detachment ordered to the Camp Malakole area?
4. Where the troops first bivouacked in the legendary 2-man pup tents, or, were pyramidal tents set up as a camp and awaiting occupancy?
5. In what area or location of the camp were the troops billeted?
6. What other commands or smaller unit organizations (if known) were assigned to Camp Malakole?
7. After August 1943 when the tempo of offensive war in the Pacific commenced to accelerated, Camp Malakole gradually became a billeting and staging area for transient troop forces. If so, where, and how, were they billeted, subsisted, and trained in the field? For example, Camp Malakole Road divided the Malakole Camp proper from the much larger limestone, limestone sink, and thick kiawe grown area to the east of the road. Questions:
8. To what purpose or use did the Army forces put this extensive area?
9. Was it a Training Area for small infantry units, company size and below, or, was it used for larger scale Battalion/ Regimental Command Post and other types of exercises?
10. This limestone area east of Malakole Road contained numerous ancient Hawaiian habitation and cultural sites made of rock and rubble walls in various shapes, as well as limestone sinks (sunken cave or pit-like depressions) also used as habitation sites. Question:
11. Were the troops instructed to avoid and respect these ancient culture sites, or, were they permitted to occupy and use them whenever available? (A recently completed archaeological study of these sites has uncovered traces of World War II artifacts, such as 1906 Springfield ammo clips, cartridge cases, C-ration cans, and other miscellaneous items. The focus and weight of the above question is meant only to correlate what, if any use, the troops made of these potentially defensive sites during their training excercises. Question:
12. Did the troops use limestone slabs or loose and scattered rock fragments to build or add additional height to the ancient rock sites, or, did they erect individual or two-man foxhole barricades to protect themselves as was done so many times in subsequent coral island campaigns, such as Peleliu in the Palau campaign?

The above interrogatory is only an approximation of the information needed. I would sincerely welcome anything in addition that you and your colleagues might consider informative about Camp Malakole. I am enclosing a stamped, self-addressed envelope for an early reply and I look forward to hearing from a fellow retired brother-in-arms.

I sincerely hope that your Regimental Reunion anniversary will be highly successful and a fulfilling experience on December 6, 1980. Please reply at your soonest convenience.

/s/ Robert H. Albert
Captain, U.S. Marine Corps
Retired

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ADDENDUM II

[Letter (handwritten) to Captain Albert, dated November 19, 1980]

Dear Captain Albert--

I was delighted to receive your letter--its good to know that someone cares besides our dying group! I think I can offer you quite a bit of help relating to your project:

Many of your questions are answered within the two enclosures ["The 251st C.A. (AA) Regiment: A Historical Summary" and "The 251st C.A. (AA) Regiment: The Coat of Arms" both dated 1978]. But, since the Regiment left Hawaii for the Fijii Islands in mid-1942, I cannot provide you with any factual information after that time.

I was one of the lucky soldiers who went to Hawaii on the SS Washington, a civilian luxury ship providing first-class service (after that it was all down hill--troop ships with salt water showers, etc.). I left the Regiment from the Fijii Islands to return for flight training and eventually flew a tour as a P-51 fighter pilot in Europe.

Since many former Regimental members still live in San Diego, we manage to maintain a close relationship. If you like, I can put you in touch with former Battalion Commanders and, in particular, with an officer who had an engineering background and was well acquainted with the construction of Camp Malakole.

I have photos of the Camp, firing range, etc., as well as a copy of the initial plan (blueprint) for the Camp.

At our December 6 meeting, I'll ask for our members (about 100 attend) to contact you if they are willing to help out. Also, one of our members has a brother who was also in the Regiment and the brother now lives on O'ahu (his last name is LEAF, John Leaf, I think, and he lives on the North side)--Anyway, I'll run down his address for you.

I'm writing this hurridly on the day that I received your letter so that you'll know that you've got some assistance coming. I'm sorry that we won't be able to help more regarding the archaeological research--, but will do the best we can.

Good luck on the project!

/s/ Bob Macdonald

ADDENDUM III

[Letter to Captain Albert, dated December 29, 1980; Coronado, California]

Dear Captain Albert--

I received your recent interesting letter regarding information on Camp Malakole. I can answer only some of your questions of what went on while we were there. I never got back to O'ahu either during or after the War. After I finished my time in the Solomon Islands I came back to Fort Bliss, Texas for extensive training to be ready for the big show in Europe. My speciality was 90MM AAA guns, so after much schooling and shooting I went to Europe with self propelled automatic antiaircraft guns on halftracks and was with the 11th Armored Division of General Patton's Third Army from Normandy to Czechoslovakia. Enough about me.

I am enclosing some photographs of some shots you might be interested in. During the construction I had little time to take snapshots. These I have are spares from the Camp Photographer, a good friend of mine. I trust you will return them. I have no objection to making reprints of them if you wish. We that are left of the old 251st Regiment are trying to get up a history and some of these photos might be used. I worked spare time for over a year on the RUF*DRAF of the history but doubt if it will ever go to print. I started back before the Civil War and took it up through Korea at which time the 251st designation went out of existance.

Usually at each Regimental Reunion we have a display of old pictures and printed items. At the 1979 event a blueprint of the camp was uncovered and displayed. It showed each and every building with roads and incidental facilities. I think Col. Lafaver keeps these items and may still have it or know where it is. He lives far out in the El Cajon area and I see him about twice a year.

I know of the limestone area you mentioned but never did more than take a short look at it. We made no use of it. There must have been some kind of a plant there long ago that used earth products of some sort. We found a couple of dilapidated buildings near by but never made use of them in any way.

Regarding the organization by units, the Regiment followed the general number of units for any artillery regiment. We had Regt. Hq and Service Battery, Band and Medical Unit. 1st Battalion had Hq Det and Combat Train, Batteries, A (searchlight), Batteries B, C, and D (3" AAA Guns, later replaced by the 90MM Guns after arrival in the Fiji Islands). 2nd Battalion had Hq Det and Combat Train, Batteries E, F, G, and H (automatic AA Guns). The Department loaned us a QM unit, there is a picture of it included. While we were at Malakole, we shared our gun line out on the beach with all needed facilities to the Marine Defense Battalions passing through that needed a range to sharpen up their AAA firing. Their Battalions had the same equipment and organization. Several of the officers of one of these Marine Battalions came through for their shot and turned out to be classmates of mine when we went to the advanced officer's AntiAircraft Artillery School at Fort Monroe Virginia just prior to my departure for O'ahu.

We had some good times over a few beers and they went on to Wake Island. They were never found on the prisoner list submitted by the Japanese.

I do not have enough information for you for more than a start of a second page.

While we worked on Camp construction and continued practice at firing at towed aerial targets along the beach adjacent to the Camp, we also had to develop our field positions spread out along the 'Ewa side of West Loch which would be our place in the AA gun ring around Pearl. In that area we seemed to get away from the solid coral formation of the Camp area. We found it to be a soft decomposed volcanic earth fairly easy to dig into with a jackhammer using a spade bit. We were told to dig bunkers below ground so that all ammo, critical items and CP could be below ground. Our people used tents for quarters. I supervised most of the Gun Battery installations and noticed in the Extensive excavations that we were in an ancient burial ground. We at once questioned if this should be and were told that since there was no record of it to keep on going for it was too old to be of any concern. It was interesting to learn that the earth must have had great properties for consuming organic material. There were never any bones found, remains of cloth or any objects of metal or stone. All we found was the unmistakable outline of a human form with the earth of a slightly different color. I mention this since you write of your Archaeological Research.

In closing, may I say that I hope you can find some information you do not already know. Again, feel free to use any of it as long as you make copies and return the originals.

I envy your perfect typing. Since my retirement, my fingers have lost their agility or should I blame it on the typewriter.

I would be pleased to hear from you again, when I hung up my 'Greens" for the last time, title hangs with it. My friends call me Ken.

Yours truly,

/s/ Ken Bandel

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ADDENDUM IV

[Portions of a History of the 251st Coast Artillary Regiment by Colonel Kenneth W. Bandel, USA (Ret.)]

Paradise of the Pacific
(The Rock)

Word was received that the Regiment would embark for Hawaii, the first National Gurad organization to be called up and now the first to leave the continental limits of the United States. The usual expected problems were met and the Regiment arrived in two boat loads. Upon arrival, the Regular Army in the Hawaiian Department was thrown into a quandry as to what to do with a National Guard Regiment. There were no quarters available to house a regiment. It was decided to farm them out to established Army Posts. Some units were sent to For Ruger, some to Fort Shafter. The Regiment was setting about to adjust itself to this new life in a new land. New uniforms were issued, new to the Regiment that heretofor had never worn anything but O.D. woolens. Now it was CKC (cotton khaki clothing). National Guard regulations were discarded for Hawaiian Department regulations; they wrote their own over there. The people were brown, fat and friendly. The food was different. The plant life was different - yes, even the ocean was different. It was so warm, swimming was like taking a bath.

Chapter XII
Malakole

The Island of Oahu has one dry side called Ewa; it is a flat coral plain densely covered with a shaggy tree named Algeroba or sometimes called kiawe. It is half tree and half bramble imported from some French possession for cattle food. The Hawaiian Department Engineer troops had started clearing off the kiawe on a beach area just up from Barbers Point and had constructed a few temporary "board up and down" structures as temporary quarters for antiaircraft troops while firing from this location. It was suggested that the 251st Regiment might be moved out there if work could be speeded up to get the camp finished. Upon presenting the idea to the 251st Commanding Officer, Col. John H. Sherman, with no hesitation he not only accepted the location as a permanent camp but insisted that his Regiment take over and finish the construction. With a bit of reluctance, the idea was approved and the engineers were pulled out. Battery by battery, Camp Malakole was occupied. The various tasks of construction were doled out to different batteries and in due course every one had a prescribed task to perform.

Building Camp Malakole was not to take presidence over the primary mission of Antiaircraft. While part of the troops were driving nails and digging ditches, others were firing the new three inch spider-mount antiaircraft guns. The automatic weapons batteries were learning the technique of firing the large cumbersome water-cooled 50 caliber machine guns. When there was nothing else to do the batteries developed field positions about the western side of Pearl Harbor. Parades and ceremonies were conducted on the newly carved-out parade ground as usual.

The year 1941 slipped by in short order and Camp Malakole was officially decleared on orders from the War Department to be a recognized Army Camp. At an appropriate ceremony in front of Regimental Headquarters, the orders were read to the assembled troops and visiting senior officers from the Hawaiian Department. The band played, the two salute guns were fired and the colors were hoisted to the top of the newly erected flagpole which had been procurred from the local telephone company and painted silver. It was all very meaningful and impressive except half way up the pole, the halyard stuck in the pulley and the colors would neither go up or down while everyone standing at "present arms" mumbled "Why don't someone do something".

The last building to be completed was the camp open air theatre and marked the one hundred and twelth building constructed. In addition to the structures was a complete sewer system. It was properly designed and properly constructed, but concrete pipe joined together with cement joints was never intended to carry sewage under pressure of an ejector pump. The result was that three times weekly, part of the parade ground and all of the firing line had two to eight inches of raw sewage covering them. The line was patched and repatched, but each time it broke out in a new place.

Col. Marquat, Regimental Instructor from the Regular Army at the time of mobilization was promoted to the rank of brigadier general and became antiaircraft officer on General MacArthur's staff in the Philippine Islands. He had developed a great love of the 251st Regiment and likewise they for him. It was found that another antiaircraft regiment was needed on Corregidor and General Marquat at once asked that the 251st Regiment be transferred from Hawaii to the Philippines. Antiaircraft officers in the Hawaiian Department argued that since a year had been spent working the 251st Regiment into the defense of Pearl Harbor, together with their extensive work on the development of field positions, it would be wiser to leave them where they were and send a new regiment fresh from the States to augment the defense of Corregidor. The result was the Hawaiian recommendation won and a National Guard Regiment from New Mexico was sent instead. It is remembered that this outfit was so badly cut to pieces before Corregidor finally fell that it was decided to break up all National Guard organizations and spread them throughout the Army of the United States to prevent one organization suffering such heavy casualties.

Chapter XIII
That Day Will Live In Infamy

Having finished the construction of Camp Malakole, the weary nail-driving soldiers settled down to serious target practices, further developing of field positions and a little sightseeing of the Islands. Life was lazy and pleasant; the beaches had plenty of little brown gals and Honolulu had plenty of service men's clip joints. To many of the soldiers their principal worry was how to beat the two.

Late in November of 1941, a Japanese diplomat Saburo Kuruso on his way to Washington to conduct peace talks, stopped off at the China Clipper Base just off John Rogers Airport and spoke a few minutes to the crowd that gathered. The Army and Navy asked any of the officers of the Hawaiian Department not too busily engaged to be present as a courtesy. The officers of the 251st Regiment will always remember how he stood in the opening to the plane and said, "I go to Washington to as you say 'make a touchdown for peace'".

The details of how the attack came on the morning of 7 December need not be repeated. At Camp Malakole, some of the troops were at breakfast, some were in the newly finished latrines reading the Sunday morning paper and having a long smoke. Japanese attack planes after making their pass at the ships in Pearl Harbor, pulled out of their dives over Camp Malakole to regroup and head back to their carriers. As they passed over the Camp, they attempted to unload their last rounds as a parting expression of their wrath. The Camp was not too badly damaged other than the motor pool taking a lot of spraying of machine guns and barracks roofs were well ventilated. The long row of latrines were constructed halfway between the barracks areas and the firing line so they would be in position to serve both areas. They were the only buildings having corrugated iron roofs. The Japanese flyers took them to be ammunition sheds by reason of their nearness to the firing line and spent a goodly portion of their remaining ammunition spraying the tin roofs up and down. There was a sudden exodus of soldiers from the latrines clad as they happened to be.

At the time of the attack, the Island was on an antisabotage alert with all the heavy weapons limbered up and parked hub to hub under heavy guard. Headquarters personnel, the Searchlight Battery and the Gun Batteries were able to take only a minor roll in repulsing the attack. They issued small arms ammunition and ispersed about the Camp area to fire at will with the 1903 Springfield rifles.

Not so the the Automatic Weapons Batteries. They lost no time getting the water-cooled .50 caliber machine guns out of the supply rooms and set them up in the Battery streets. In a matter of minutes a deadly fire was delivered with what ammunition was belted up. Meanwhile, those not on guns were belting up more ammunition. The tragedy of the morning happened to Capt. Lyman's battery when they mounted their machine guns like clock work but found to their horror that the guns were set for opposite feed to the loading of the ammunition chests. It seemed for a short time that they would not get in on the firing, but with typical alacrity, the ammunition was removed from the chests and fed to the guns by hand.

One Jap plane was seen to go down into the ocean after his fateful pass over Camp Malakole and a second was seen to disappear trailing smoke. Credit was given the Regiment for the destruction of two planes.

Sgt. Childress of Battery B, sleeping late that one Sunday morning had a Jap 7.7 caliber machine gun bullet go through the roof of the barracks and into his abdomen. He recovered from the wound, entered OCS and the last news of him was that he was a captain in the Regular Army.

One incident of combat must be described for its significant indication of the activity during the attach and for the most part, the spirit of the Regiment and the National Guard.

Not all of the automatic weapons batteries were fully equipped with .50 caliber machine guns; there were still several of the old water-cooled infantry .30 caliber guns used for basic training of antiaircraft automatic weapons gunners. Three men of the Second Battalion teamed together and set up one of the .30 caliber machine guns in the battery street and opened fire on a Jap plane that made a strafing pass at the camp. One of the men was a bugler that had just finished blowing "boots and saddles" to alarm the camp. His bugle was still slung across his shoulders. The other two men were cooks from the nearby mess hall that left their duty of frying eggs and bacon to get into the fight. The bugler got hit by a round from the Jap pla e, the 7.7 caliber bullet passing through the front of his chest from one arm to the other. One of the cooks pulled the wounded bugler from the breach of the gun and pushed him to the ground before he passed out. The cook then took over the gun and continued to fire on the Jap plane as it left the camp. The last view of it showed smoke issuing from the engine. It was reported to have crashed into the ocean about a mile off shore. This incident establishes the 251st Regiment as the first National Guard organization to draw enemy blood and the first antiaircraft outfit to bring down an enemy plane.

Capt. Clifford Beyers was Camp Officer of the Day during 7 December and found himself well occupied with the first duties when a Camp comes under attack. Units were to be alerted, orders issued to prepare all guns to fire in protection of the Camp. The prisoners in the Guard House had to be released and ordered to their units. It was noteworthy that during the stay in Hawaii the 251st Regiment never had a prisoner charged with a felony; those having guest quarters in the Guard House were largely boys inexperienced in the art of holding their beer properly. With this in mind, releasing the prisoners was done with never a thought of their going anywhere but to get weapons and get into the fight. While running down the main street of Camp, Capt. Beyers observed a Jap plane making a pass at the camp with guns blazing. The natural reaction followed; being armed only with a pistol he dived into a ditch beside the road, emptied the pistol at the plane. It is not recorded that the pistol was too effective but it was better than the Navy men that went to their death throwing potatoes from the burning decks of their ships in Pearl Harbor. Capt. Beyers noted the Japanese gunner in the rear cockpit delivering an age-old American gesture of contempt as the plane passed overhead not more than a hundred feet off the ground, by thumbing his nose. The Captain came out of the incident without a scratch and remained with the Regiment through the Island campaigns to the close in the Philippines. He organized and commanded the 234th AAA Group in Long Beach after the War and was promoted to Brigadier General in command of the 114th AAA Brigade. He still retains that command at this writing.

It is said that the Regimental Commander, Col. John H. Sherman, was the coolest person in the Regiment during the attack. He remained at Regimental Headquarters, stepping outside from time to time to observe enemy planes passing overhead. Many officers ran to Headquarters for orders or special instructions. Col. Sherman received them with a little irritation and scorn and delivered a statement that is remembered down through the years. He said, "There are no orders, just get into the fight".

In due time guns were limbered up and all batteries rushed to their field positions to prepare for a renewed attack which never came.

Battery D arrived at its position near West Lock to find a raging fire burning within the position. It proved to be a U.S. Navy fighter locked with a Jap torpedo plane in mid-air and fallen together. When time would permit, the men of Battery D removed the remains of the Navy Pilot from the wreckage and learned from his identifications that he was Ens. Voss, recently graduated from San Diego State College and a close friend of many State men within the Regiment.

As we look back upon the events of that fateful morning of the 7th it is found that the 251st was noteworthy for its many "firsts" at this time. It was the first National Guard organization to be called into Federal Service and first to leave the continental limits of the United States. It was the first Guard Outfit to fire in the first battle of World War II. It had the first two men of the Armed Forces killed and the first Guardsman wounded in action.

Two soldiers in the Second Battalion that were brothers by the name of Rasmussen had taken off from a civilian flying field in a light plane headed for a days outing at another island. They had filed a flight plan that took them in the exact direction to meet the first wave of attacking Japanese. They were never heard from.

The following two weeks after the attack were spent in intensive preparations for the defense of the Island should there be a follow-up of the first attack. Many trips were made back to Camp Malakole for tools and materials needed at the field positions.

One incident of an amusing nature was found in the Officer's Club at Camp Malakole following the attack. The Club was also used as a classroom for the officer's gunnery school. The following are quotations from lines written on the blackboard:

3 December (no gunnery school - Wednesay afternoon recreation)
4 December (no gunnery school - Scheduled instructor ill)
5 December (no gunnery school - Preparation for Saturday inspection)
No entry for Saturday 6 December or 7 December
8 December (in large red letters) IF YOU CAN'T SHOOT NOW, IT'S TOO DAMN LATE!

War Is On

Having recovered from the initial attack on Pearl Harbor and accepting the realization that there was to be no immediate follow-up nor invasion of the Hawaiian group of islands in the very near future, the Regiment dug in for a full static defense of the Port installations. A killing pace was set to continue training, further development of field fortifications, the reorganization of the antiaircraft defense. The working day was set-up to keep things moving on a twenty-four basis. Officers and men spent four hours at their respective stations, either on weapons or at command posts, then four hours developing field fortifications, followed by four hours rest. This went on around the clock for two weeks. By that time people were out on their feet and the general efficiency was dropping to a dangerously low condition. A new schedule was put into effect where night work on fortifications was reduced to daylight hours only unless one had a night shift at the CP or on weapons, a full nights sleep was available.

It was soon seen that antiaircraft regiments as such were too cumbersome to be effectively employed in a static situation. The group system was coming into being and while the 251st Regiment retained its organization for the purposes of administration, tactically the two battalions were farmed out to provisional groups.

The West Group was created to cover the western side of Pearl Harbor. It was commanded by Col. Ronald M. Harris, who was also Commanding Officer of the 1st Battalion, a main part of the West Group Defense. To augment the defense, five inch dual-purpose Naval guns were unbolted from the decks of sunken battleships and permanently emplaced in concrete. A newly called up reserve regiment, the 95th Antiaircraft Artillery was assigned these positions.

The West Group command post was located in an Algeroba grove on the Ewa plantation. A structure was built from salvage materials and then covered with chunks of coral creating a roof and walls averaging three to four feet thick. It may not have been bombproof to a direct hit, but it was believed it would stop a few splinters.

At the time of the attack, the gun batteries averaged ninety men per battery where they should be allocated 159. Short handed as they were, the kitchen section would man one gun and the motor section a gun also. The Battleship Nevada started to steam out of the harbor during the attack, but upon receiving several hits was afire and taking water too badly to go to sea. Her skipper beached her just opposite the position of Battery B of the 1st Battalion. When the fires were extinguished, personnel came ashore to find something to do of a useful nature and someplace to stay. One gun crew of Navy gunners and one crew of Marine gunners wandered into the Battery "B's" position and were adopted at once by Capt. Clyde Randel the Battery Commander. Short-handed as he was, these trained gunners were a welcome addition. Word was sent to Naval Headquarters at Pearl Harbor concerning the status of Naval personnel in an Army gun battery. The answer was returned, short and clear, "If you can feed and clothe them, keep them". For quite an extended period Army, Navy and Marines worked and lived together in close harmony. The day finally came when the Naval personnel would have to return to other assignments. Battery B let them go with regrets and they left with a great reluctance. A lasting impression was left in Battery B that took a year to remove. The Army language of the men was completely defiled with such terms as "deck", "head", "galley", "bulkhead", "bearing" instead of azimuth and "port and starboard gun clocks".

ADDENDUM V

Selection of contemporary photographs of Camp Malakole (Figures 106-111, 115, 117, 126. 127,129) supplied by Colonel Kenneth W. Bandel USA (Ret.). Figures 112-114, 116, 118, 119-125, 128, 130, provided by Major John M. Leaf USA (Ret.). Captions researched and written by Captain Robert H. Albert USMC (Ret.).

Figure 106

In November 1940 a tent camp for the billeting of troops was quickly established in the Camp Malakole area following the arrival of regimental contingents. This is an excellent close-up photo of the army general issue tent, canvas, pyramidal. Held erect by a central tent pole, the canvas fabric is heavily waterproofed and durable in all climates. A single tent comfortably billets eight troops with canvas folding cots (two per side), of which one may be seen inside the flap entrance. A plywood or wooden decking is first laid down before the tent is pitched, to provide some domestic comforts. Stout hempen guy lines, with simple adjusting clamps, are secured to double-notched hardwood tent pegs. The entire bottom flap below the sloping upper skirt is adjustable for climatic conditions and may either be left down or rolled up. Note the utility power lines extending down the battery streets with separate lines dropping to each tent. A single drop cord and one naked, low watt bulb per tent was normally authorized. Here the final stages of erection are being completed as a soldier slides down a corner of the skirt after adjusting the vent cap at the peak. Three others below enjoy themselved holding guy lines taut as another supervises. Judging from the damp ground surface, muddy grass, and the hasty shallow drainage ditch along the tent row, the camp may be recovering from the heavy downpour which flooded this area during the Thanksgiving week of November 19-20, 1940. Pre-war national guard uniforms may be seen in the coveralls, two-piece fatigue or work uniforms, khaki trousers and OD shirt, and the "Smoky Bear" campaign hats.

(Bandel Photo #222)

Figure 107

Young California national guardsmen of the 251st Coast Artillery (Antiaircraft) Regiment develop teamwork in the construction of Camp

Malakole, and demonstrate why the war was won. Here a row or street of barracks foundations are seen in various stages of construction. Note the generous use of crushed coral to surface the road net. In the center foreground a three-man team works together producing uniform-length pier posts for structure support. Since electric power tools were unavailable at that time, necessity provided the muscle, sweat and manpower as artillerymen became construction engineers to get the job done. This crosscut saw team makes short work of two pier posts while a third man tends a jig form. In the center background a vintage army truck of the 1930's, forerunner of the heavy duty combat vehicles of World War II, delivers a load of sand and gravel for cement to pour the concrete footings in place. Left middle background a nearly completed foundation and flooring. A carpenter team is installing the foundation sills as a bearing surface for the walls.

(Bandel Photo #H144)

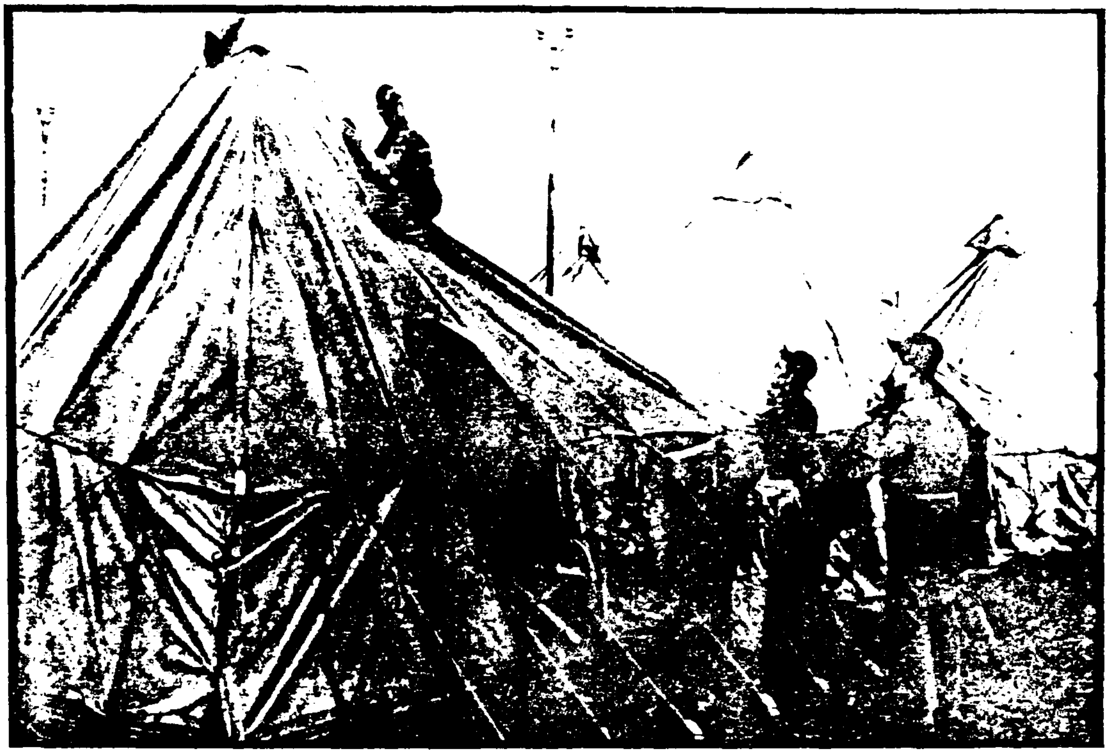

FIGURE 106 MALAKOLE TENT CAMP (BANDEL PHOTO 222)

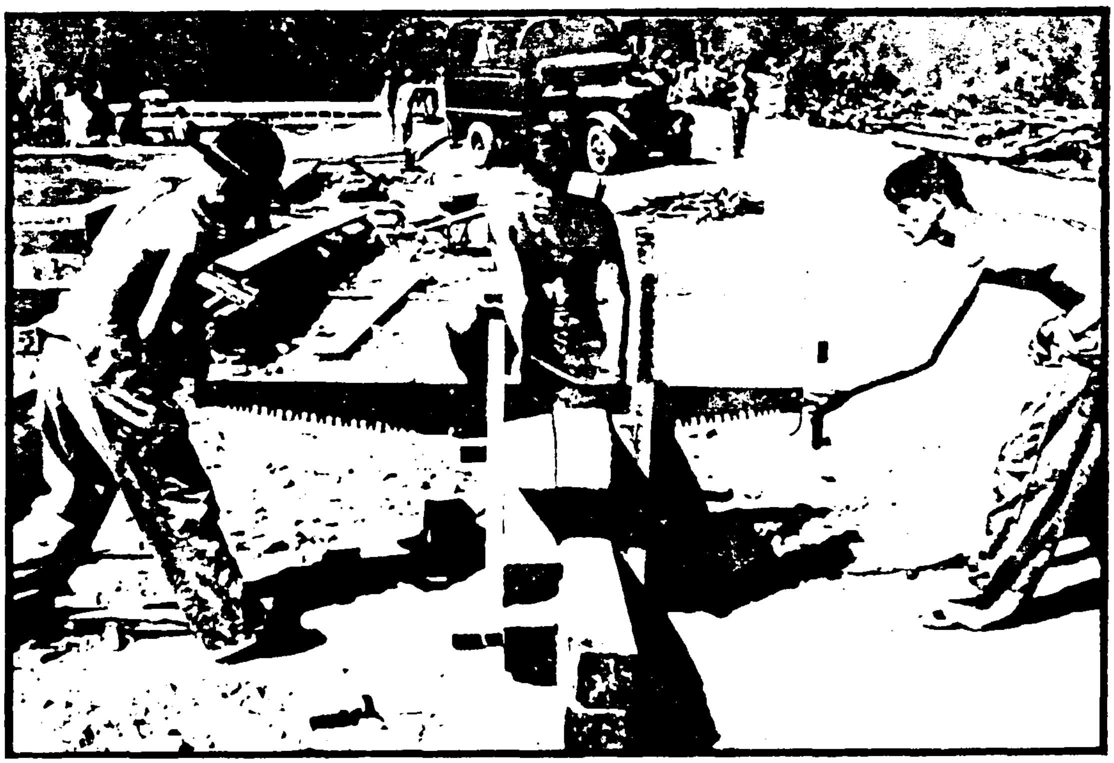

FIGURE 107 CUTTING PIER POSTS FOR CAMP MALAKOLE (BANDEL PHOTO H144)

Figure 108

With the barracks wall framework bolted and braced in position, a five-man roofing team commences the task of raising individually prefabricated roof-rafters into position to form the simple gable roof. The man aloft is checking the alignment of the last rafter up while the other four are preparing to hoist the next rafter to be positioned. Note the thick kiawe growth in background, heavily powdered with a snow-like dust. The clearing for an adjacent battery street may be seen through the trees.

(Bandel Photo #324)

Figure 109

During one of the follow-up phases of barracks construction at Camp Malakole, a team of electricians are wiring the barracks to the main power transmission line. A series of drop-cord lights will be wired through the length of the barracks. An interested spectator at this particular function is Colonel John H. Sherman, the Regimental Commander. This excellent photo of the exterior end of a completed barracks provides super detail for photo interpretation. From the top down, the light gray tarpaper roof covering reflects much of the solar heat and precludes leaking during rainfalls. Note the harmonious texture in the vertical sheathing of the exterior walls, the wire-screened windows and hinged window shutters which may be adjusted for climatic conditions. The poured in place concrete footings and sturdy pier posts elevate the barracks sufficiently for cooling air circulation through and around the structure. The elevation negates any danger of heavy floods. Notice the stenciled fire buckets on the wall rack, and below it, the covered, water-filled 55-gallon drum for fire emergency. For aesthetic reasons, a small thicket of kiawe trees was left standing in the background, a policy carried out in the camp wherever possible. The visible concrete and coral rubble debris will be policed up when the construction is finished.

(Bandel Photo #137)

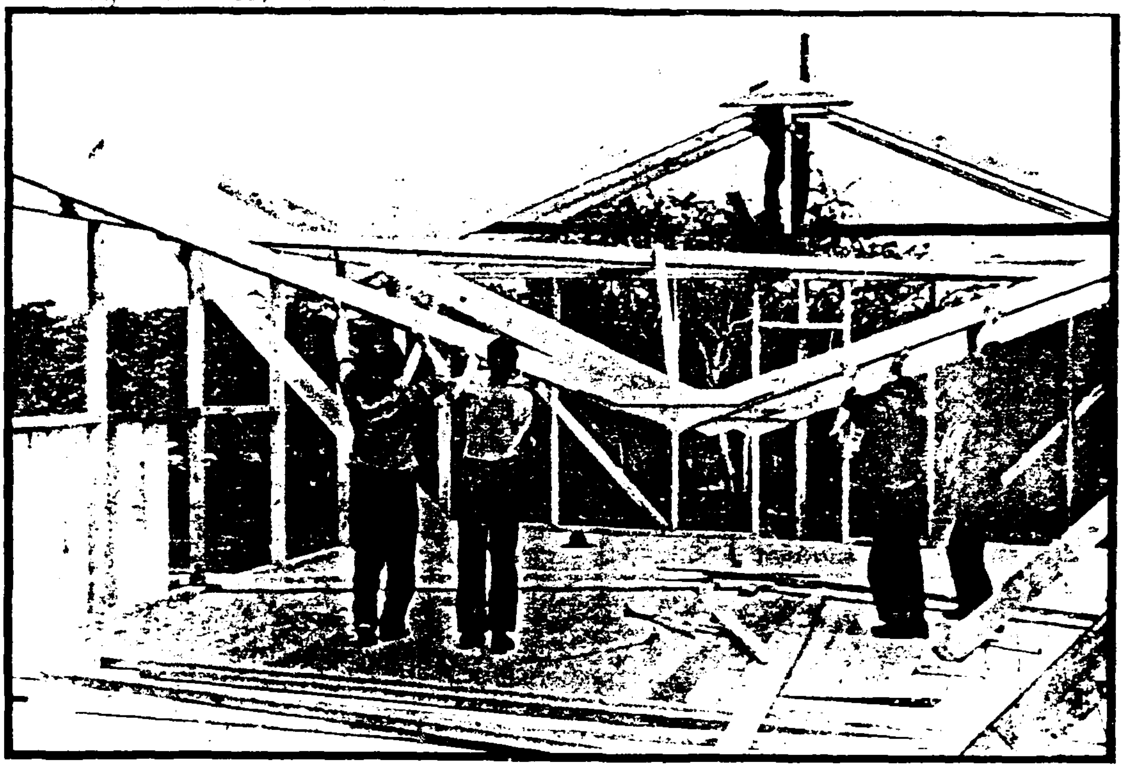

FIGURE 108 RAISING BARRACKS ROOF RAFTERS, CAMP MALAKOLE (BANDEL PHOTO 324)

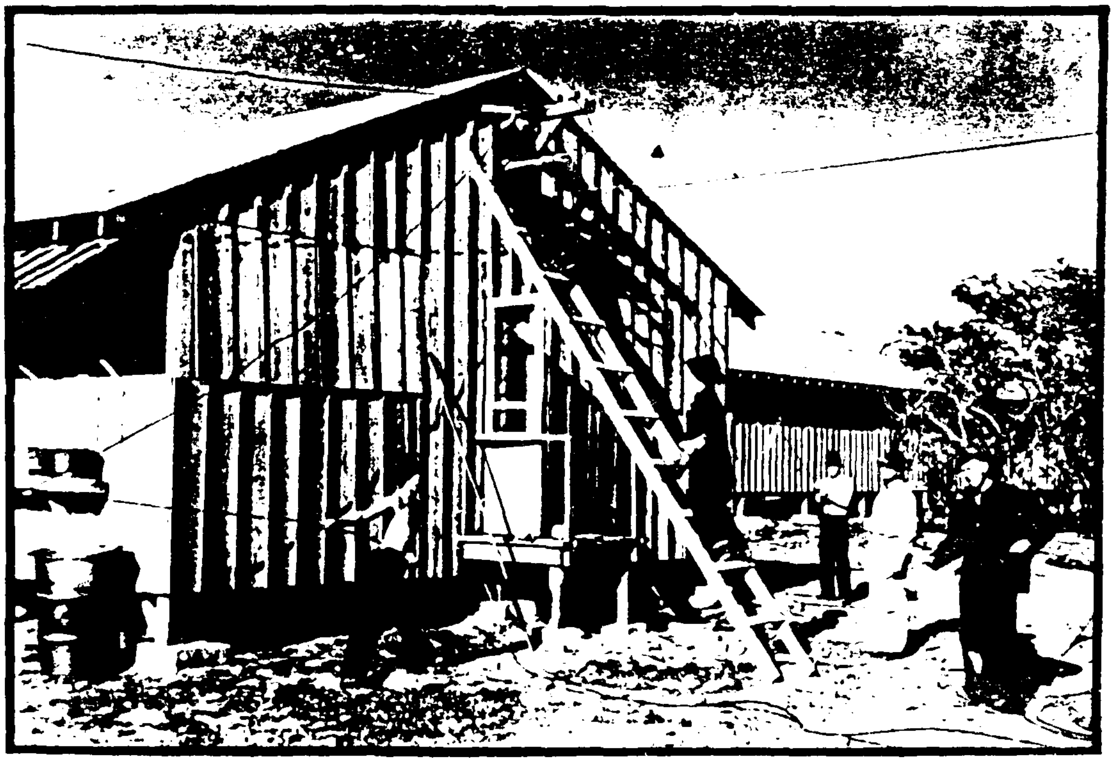

FIGURE 109 WIRING THE BARRACKS, CAMP MALAKOLE (BANDEL PHOTO 137)

Figure 110

Inspecting the ongoing construction of a high-capacity, multi-chambered, concrete septic tank at Camp Malakole, visiting members of the Army Corps of Engineers at Fort Shafter are accompanied by the Camp Commander, Colonel John H. Sherman (foreground) and his staff. Here the reinforcing iron gridwork for chamber walls have been fabricated and wait wooden forms for pouring. The entire sewerage system was designed for a camp population of 2,000 men. For pertinent comments concerning the early operation of the completed system, refer to the appended historical notes provided by Colonel Kenneth W. Bandel, USA Ret., who helped participate in the overall camp construction.

(Bandel Photo #198)

Figure 111

The strenuous, enervating dawn to dusk work cycle of regimented construction and training at Camp Malakole was not without occasional periods of carefree recreation and entertainment. As this scene relates, during an early phase of camp construction the textured lumber floor of a barracks foundation has been pressed into service as an elevated stage for a hula program. Blue 'Ewa skies, white clouds, and dusty green kiawe trees form a perfect backdrop as these Californian malihinis of the 251st Coast Artillery (Antiaircraft) Regiment gather near the stage in rapt attendance to enjoy the sorcery and delight of Laka, the enchanting goddess of hula.

(Bandel Photo #179)

FIGURE 110 ENGINEERS INSPECTING THE CONSTRUCTION OF A SEPTIC TANK, CAMP MALAKOLE (BANDEL PHOTO 198)

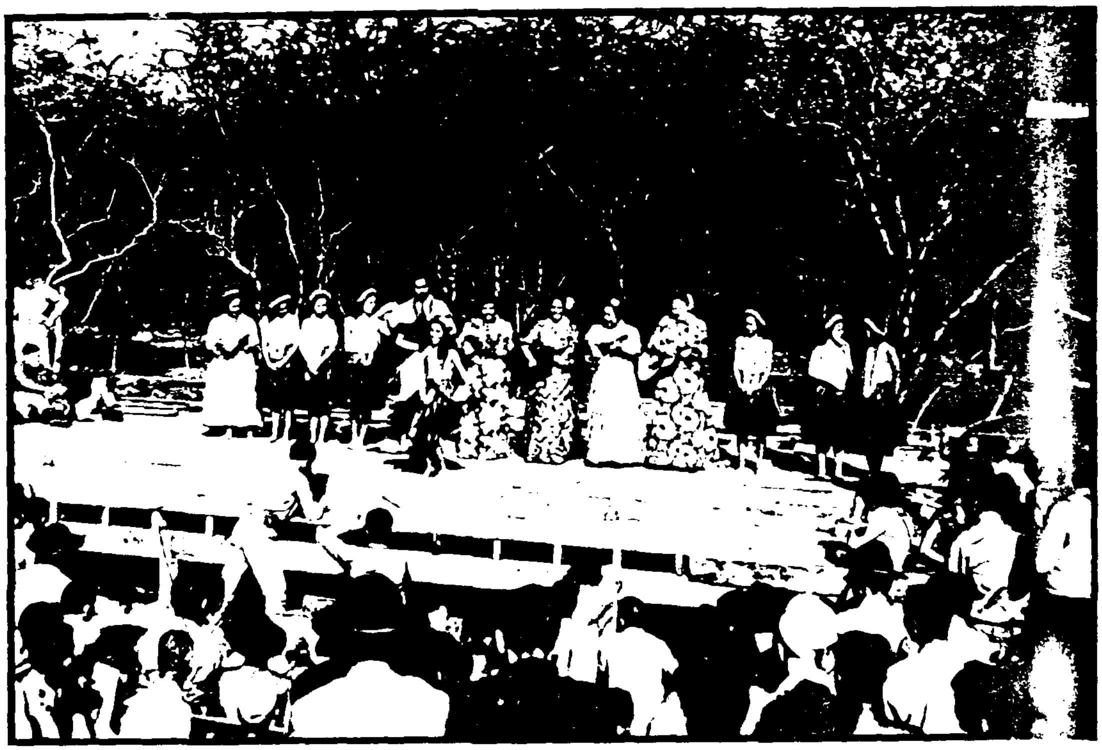

FIGURE 111 HULA PROGRAM, CAMP MALAKOLE (BANDEL PHOTO 179)

Figure 112

This is the interior view of a battery office that occupies one-half end of a Camp Malakole barracks. The desks are simple tables assembled from scrap lumber by talented soldier-carpenters. Chairs could be issue or non-issue, and may have been "scrounged". File boxes and book cases along the wall are wooden crates with built-in shelves. Since there was no piped-in water (reserved for camp kitchens and latrines), a white enameled 5-gallon liquid dispenser sits on top a wooden crate. The barracks is wired for lighting with a drop-cord light over the desks. Note the two-plug utility outlet on the wall over the master sergeant's shoulder. Third person from left is Staff Sergeant John M. Leaf, his overseas cap perched at a rakish angle, as he works with his associates to handle the demands of battery paperwork.

(Leaf Photo #016)

Figure 113

A domestic billeting scene in a newly constructed Camp Malakole barracks around early 1941. New, tubular-steel folding bunks, having replaced the former canvas cots, are neatly aligned along the walls and spaced at close intervals. Individual footlockers, containing clothing, equipment and personal effects, are uniformly supported at the foot of each bunk on wooden frames fabricated by their talented carpenters. In close barracks living quarters like this, sleeping arrangements are generally alternated head to foot, as seen here. Each bunk is furnished a medium thin mattress, a pillow, and two wool blankets. Some spare uniforms may be seen hanging from wall rafters. A single drop-cord bulb provides light for this area and some utility outlets are spaced along the walls. Two steel folding chairs may be seen in the foreground but generally, the troops sat on the sides of their bunks. Here three resident "plankowners" give life to the scene as one rummages through his foot locker while carrying on a "bull session" with his neighbor. The third soldier stretches out, relaxing over a newspaper.

(Leaf Photo #030)

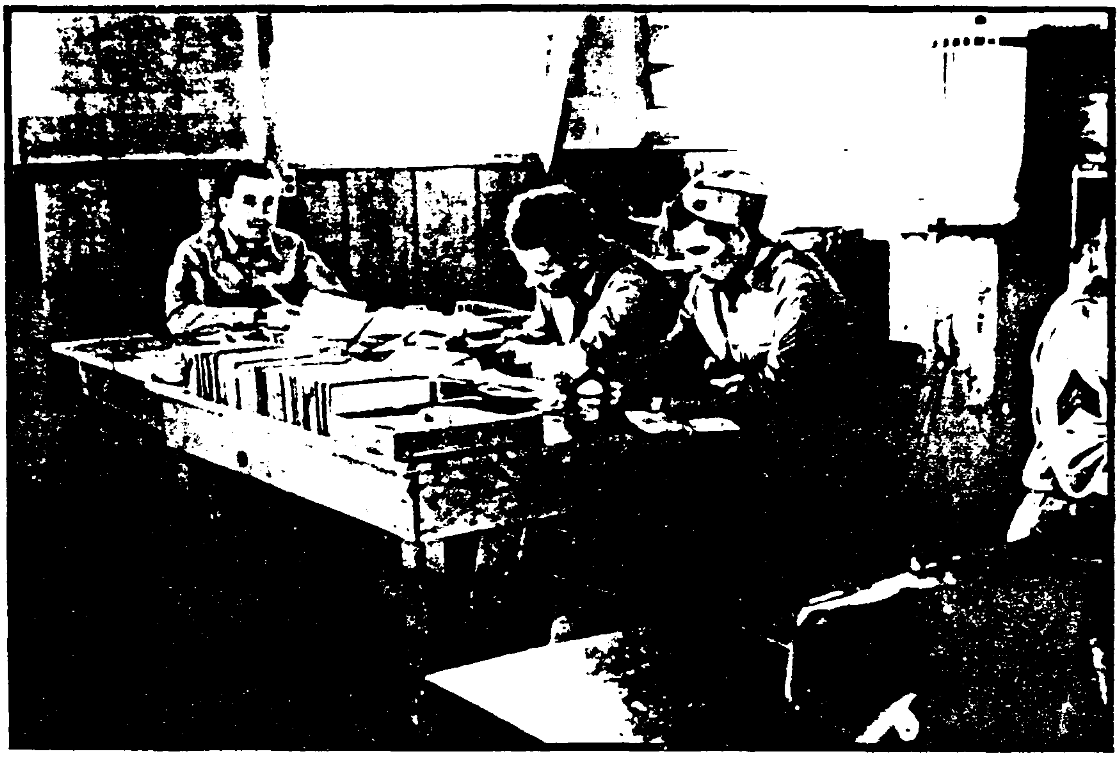

FIGURE 112 BATTERY OFFICE PAPERWORK, CAMP MALAKOLE
(LEAF PHOTO 016)

FIGURE 113 DOMESTIC BILLETING, CAMP MALAKOLE
(LEAF PHOTO 030)

Figure 114

The working interior of a battery kitchen at Camp Malakole, one being provided for each battery in the regiment. Food services was one of the two camp installations provided a piped-in water system. Visible here in the food preparation area is a medium sized, three-compartment, freezer/refrigerator for storing perishable foods. Heavy bags of non-perishables (legumes, etc.) and fresh vegetables (potatoes, carrots, onions, etc.) are stacked nearby. In the foreground are makeshift work tables for food preparation. Hung overhead is an assortment of cooking implements. Not visible are the portable, multi-purpose field ranges for cooking and baking. Using a preplanned weekly menu and guided by a wide varity of Army food service recipes, the Army Mess Sergeant, here in white apron and chef's cap, with his crew of assistants, are among the unsung heroes of World War II for their faithful service. Operating on a fixed, consolidated ration allowance per person, per month, required expert budgeting and constant supervision. In this pleasant scene, seemingly oblivious to the camera, the soldier on the left is preparing vegetables ("spudpeeler"), while the Mess Sergeant and his assistant cook pause for a moment as they chop up a head of cabbage.

(Leaf Photo #019)

Figure 115

A view of the other side of the kitchen, or a battery mess hall in full operation during the noon dinner hour on or about September 16, 1941 at Camp Malakole. Three rows of picnic-type tables extend from the kitchen in the far end where a serving line, cafeteria style, is seen dispensing food and cold beverage. Here the troops are enjoying their lunch as they intermingle in a potpourri of uniforms that fairly indicate their daily work assignments. The food and beverage portions appear to be ample, but no one goes hungry, and even the larger appetites would be welcome back for "seconds". If all the battery personnel are present, and depending on the ration count for the day, approximately 160 men or more will be served. What gives interest to this excellent pre-war picture is a study of the individual food containers and eating implements being used by the men. Used during, and handed down from World War I, are these field mess equipment items: a heavy duty set of knife, fork and spoon, a curved aluminum canteen cup with a folding handle, and two aluminum oval-shaped food containers with the odd nomenclature of "meat can" and "meat can cover". All combine together into a compact set, and with a set issued to each individual, each man is repsonsible to wash and keep it clean. After each meal, large containers of scalding soapy and rinsing water, heated by kerosene fueled immersion burners, are available for the individual washing of messing utensils.

(Bandel Photo #H-129)

FIGURE 114 A BATTERY KITCHEN, CAMP MALAKOLE
(LEAF PHOTO 019)

FIGURE 115 A BATTERY MESS HALL IN FULL OPERATION, CAMP
MALAKOLE (BANDEL PHOTO H129)

Figure 116

Humorously equipped and prepared as a two-man fighting team for any contingency, Staff Sergeant John M. Leaf (viewers right) with the fixed bayonetted Springfield M1903 rifle, and his Camp Malakole buddy, Paul Valle, pose for posterity outside their barracks. Of special importance, however, is the odd-appearing device in their left background near the barracks. Hanging chain-suspended from a sturdy tripod is a portable water container known as a "Lister bag". Its exterior surface and cover is of fine-woven white canvas fabric, while the interior is lined with impermeable rubberized material. Spaced equidistantly near the bottom are four metal plunger-type faucets for drawing drinking water as needed. One Lister bag is spaced at each alternate barracks. These bags are kept refilled from a mobile water tank on a daily schedule. A neat, triangular, gravel-filled sump below the bag absorbs the spill, and wherever possible, the bags are erected in the shade.

(Leaf Photo #02)

FIGURE 116 A TWO-MAN FIGHTING TEAM WITH A LISTER BAG, CAMP MALAKOLE (LEAF PHOTO 02)

Figure 117

During its early 1941 construction/establishment phase, Camp Malakole was assigned a separate Quartermaster liaison branch unit from its parent by the Hawaiian Department at Fort Shafter. Its purpose was to expedite and fulfill the supply and logistics requirements for the camp. With a proud staff displaying their office and warehouse "shingles" for business, this standardized barracks structure has been elongated and modified for offices, staff billeting, and warehouse functions. This Quartermaster unit became the forerunner of what later developed into a designated Supply Distribution Point for the 'Ewa/Wai'anae sub-camps and a Sub-Depot for the regional storage of Reserve Stocks of Clothing and General Supplies. Framed by the kiawe in the background, a spare kitchen refrigerator sits on the warehouse loading dock; below it are crates of equipment waiting to be processed. Note the attractive crushed coral foreyard with a wooden duckboard walkway and emergency fire equipment. A rare standing water pipe is seen in the near right foreground. Landscaping activities and plants may be seen in the raised, circular rock wall-bed holding a freshly planted coconut seedling, and also the modest planter box along the office porch.

(Bandel Photo #389)

Figure 118

"Limbered up" or converted to its most compact mobile configuration, stands a three-inch (the diameter of the gun's bore) antiaircraft gun of the 1st Battalion (B, C or D Battery), 251st Coast Artillery (Antiaircraft) Regiment. It is coupled from, or ready to be coupled to, its prime mover truck at the Camp Malakole firing line. The extended spider-mount legs of two other guns are visible behind it. Standing at right background is one of the steel observation towers that were always manned during firing exercises; the safety precautions for aircraft and boats being of paramount importance. Troops to left of tower exercise their fire direction equipment. The fringe of kiawe trees beyond the tower mark the northern camp boundary. Barely visible in the far northwestern sector of the firing line are the deployment and firing of the automatic antiaircraft guns - the cumbersome water-cooled 50 caliber and 30 caliber machine guns.

(Leaf Photo #01)

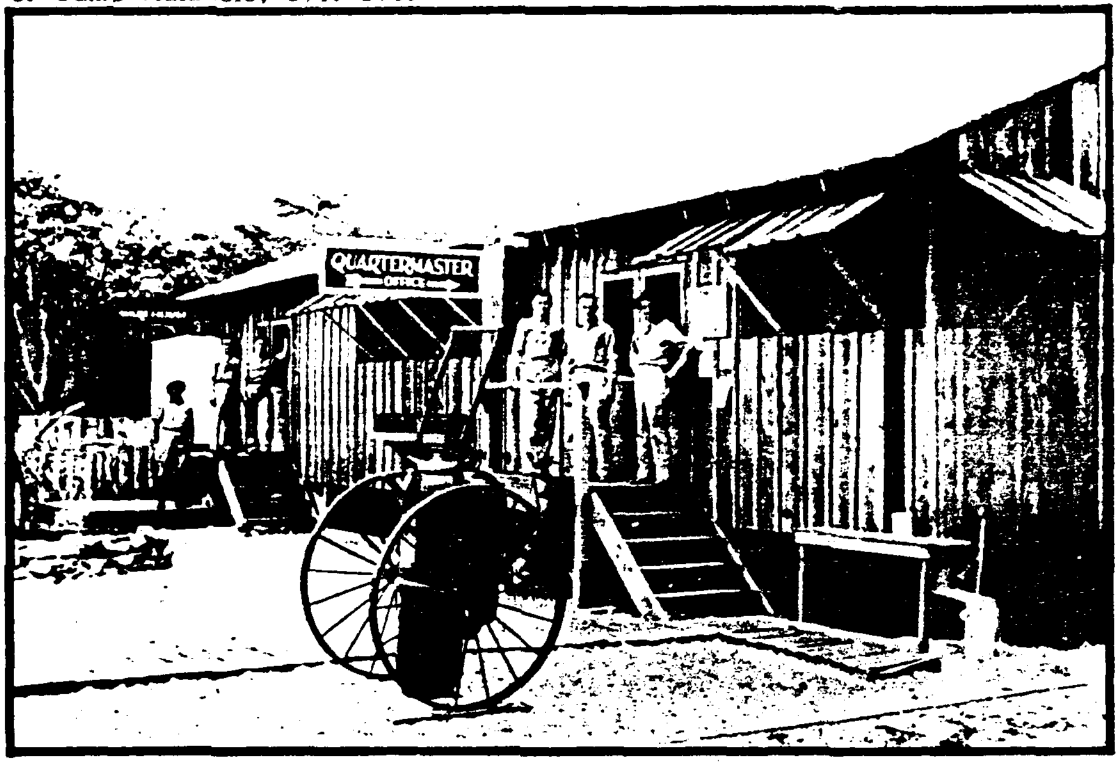

FIGURE 117 THE QUARTER MASTER BRANCH UNIT, CAMP MALAKOLE (BANDEL PHOTO 389)

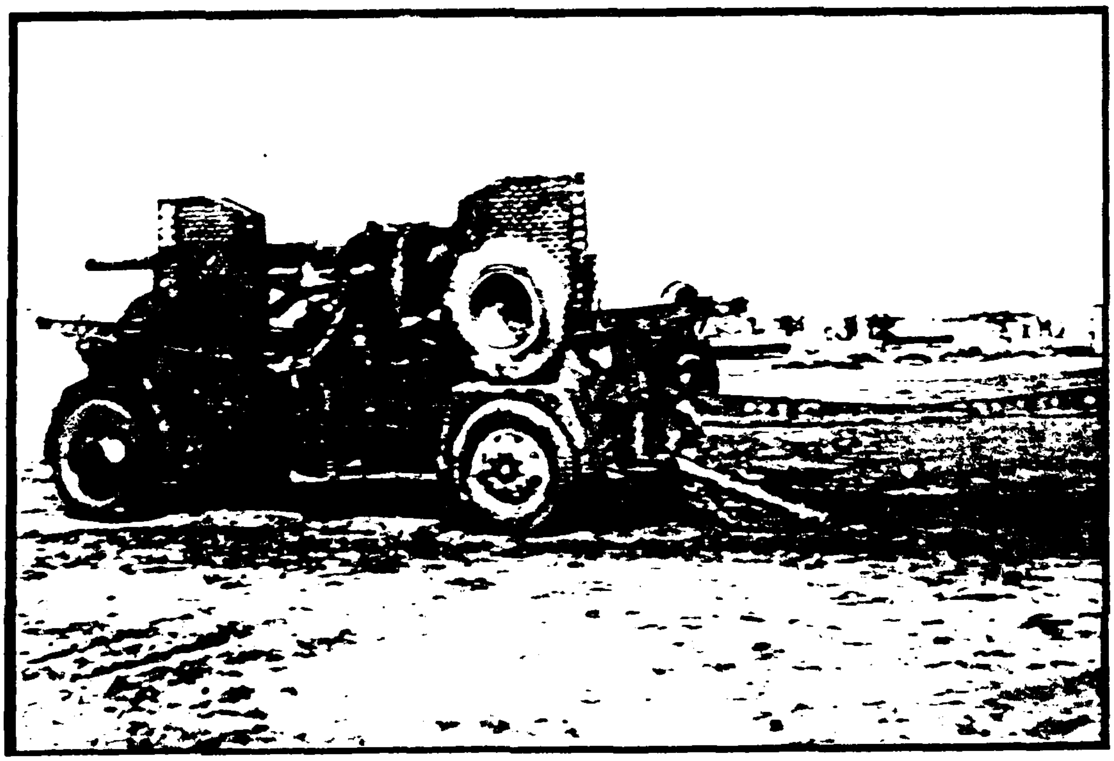

FIGURE 118 A LIMBERED UP THREE-INCH ANTIAIRCRAFT GUN, CAMP MALAKOLE (LEAF PHOTO 01)

Figure 119

Unlimbered on the Camp Malakole firing line and in defilade of the coastal sand dune fronting the beach, a three-inch antiaircraft gun is in the ready to fire configuration. The four spider mount legs are fully extended to provide maximum gun stability. The perforations of the legs and circular gun platform both reduct weight and increase structural strength. The soldier at the breech mechanism gives scale to the weapon which requires a crew of twelve, including ammunition handlers. The escalloped wooden frame device in the left foreground holds the ready rounds of fuzed ammunition.

(Leaf Photo #010)

Figure 120

Exercising individual gunnery skills that demand the optimum in teamwork and esprit, members of an antiaircraft gun crew load a fuzed round of ammunition into the breech of their three-inch gun during firing exercises at Camp Malakole. Range, azimuth, fuze setting, and other firing data are transmitted to the gun crew from a fire direction center located behind the firing line. The gun barrel appears elevated to seaward at an angle of about 45 degrees. In the background are the hazy outlines of the sand dune fronting the ocean. The mixed work uniforms of denim coveralls to two-piece pants and shirt with floppy fatigue hats date this picture as pre-war 1941.

(Leaf Photo #012)

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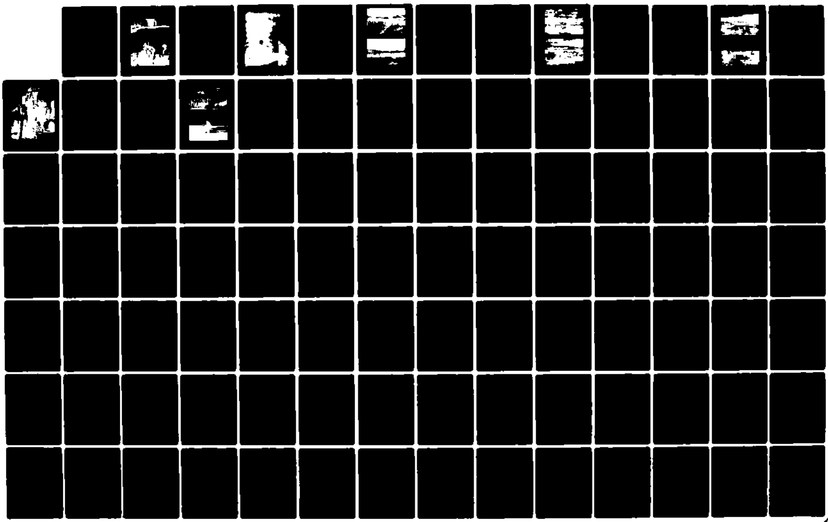

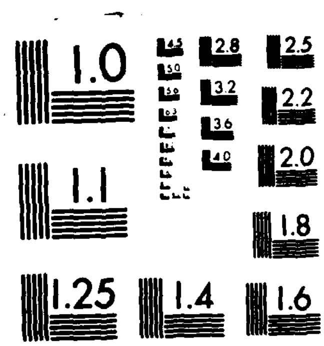

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

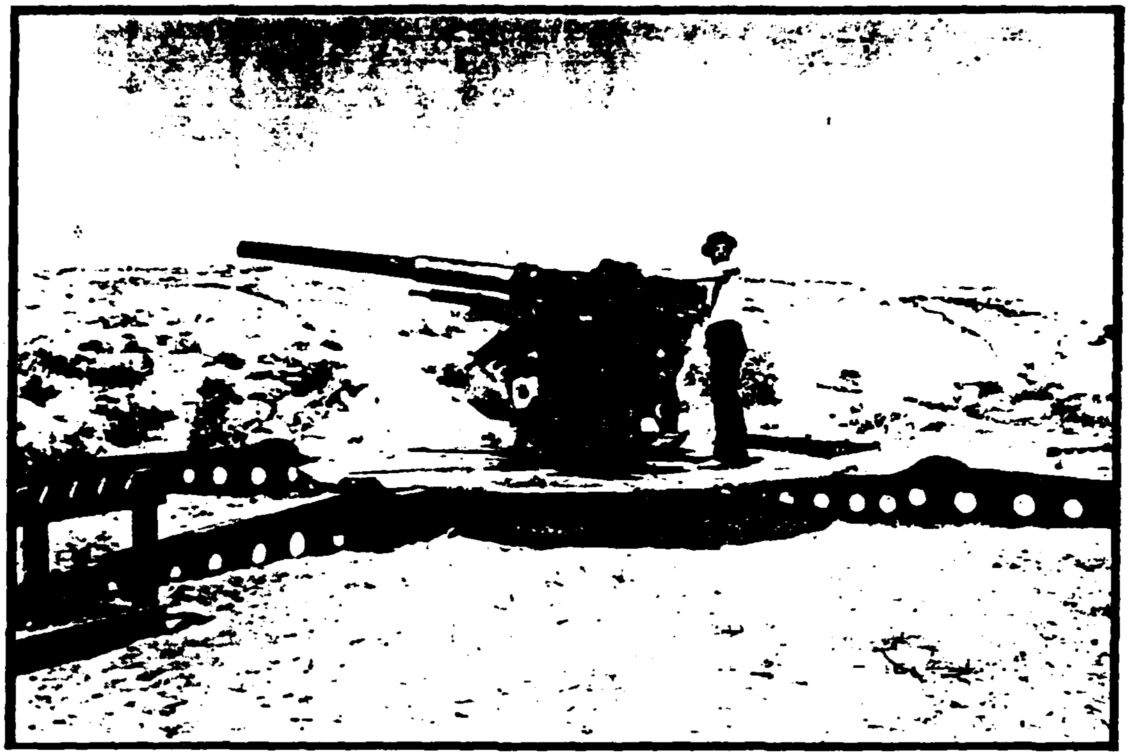

FIGURE 119 AN UNLIMBERED THREE-INCH ANTIAIRCRAFT GUN, CAMP MALAKOLE (LEAF PHOTO 010)

FIGURE 120 LOADING A THREE-INCH GUN, CAMP MALAKOLE (LEAF PHOTO 012)

Figure 121

Split-second action on the firing line at Camp Malakole, with the sand dune barely visible in the background to the right. Not the same gun crew as in Figure 120, this remarkable picture was snapped by the photographer at the instantaneous moment of firing. Here the lens freezes the barrel and breech mechanism in full recoil position. The expended shell casing, already extracted and ejected, has fallen under the crewman's left foot while a fresh round is being passed up for reloading as the breech mechanism returns to normal battery position. Note the dark vortex of powder smoke above the clearly defined muzzle blast, while shock waves stir up clouds of dust around the gun position.

(Leaf Photo #013)

FIGURE 121 FIRING A THREE-INCH GUN, CAMP MALAKOLE (LEAF PHOTO 013)

Figure 122

An oblique view of the gunnery firing line at Camp Malakole, the fringe of kiawe trees in the background orienting the northern camp boundary. Groups of Fire Direction Center personnel are assembled for instructions and work preparation. The pyramidal tents along the line provide equipment storage. This close-up view shows the partial depth of the firing line which approximates about one-third of the camp area. The original clearing of vegetation by bulldozers and graders have left symmetrical row lines of coral and limestone rubble in place, while a mound of rock debris has been gathered in right foreground. Under the low-lying cloudbank may be seen the mauka (upland) slopes of the Waianae Range.

(Leaf Photo #09)

Figure 123

Only three guns of a four-gun antiaircraft battery are visible in this action photo on the Camp Malakole firing line. Two crew members of the fourth gun are seen on the right. While the other gun crews are temporarily working, resting, or observing this action, a quickly dissipating cloud of dust around the right gun indicates it has just fired a projectile and its crew members are leaving the gun platform at the end of the firing mission. An expended shell casing is seen closeby on the ground. Camp Malakole was an ideal location for this type of gunnery training with impact area to seaward. Its facilities were shared before and during the war with other military organizations, including the First Marine Defense Battalion which participated in the heroic defense of Wake Island, December 8-22, 1941.

(Leaf Photo #06)

FIGURE 122 FIRING LINE, CAMP MALAKOLE (LEAF PHOTO 09)

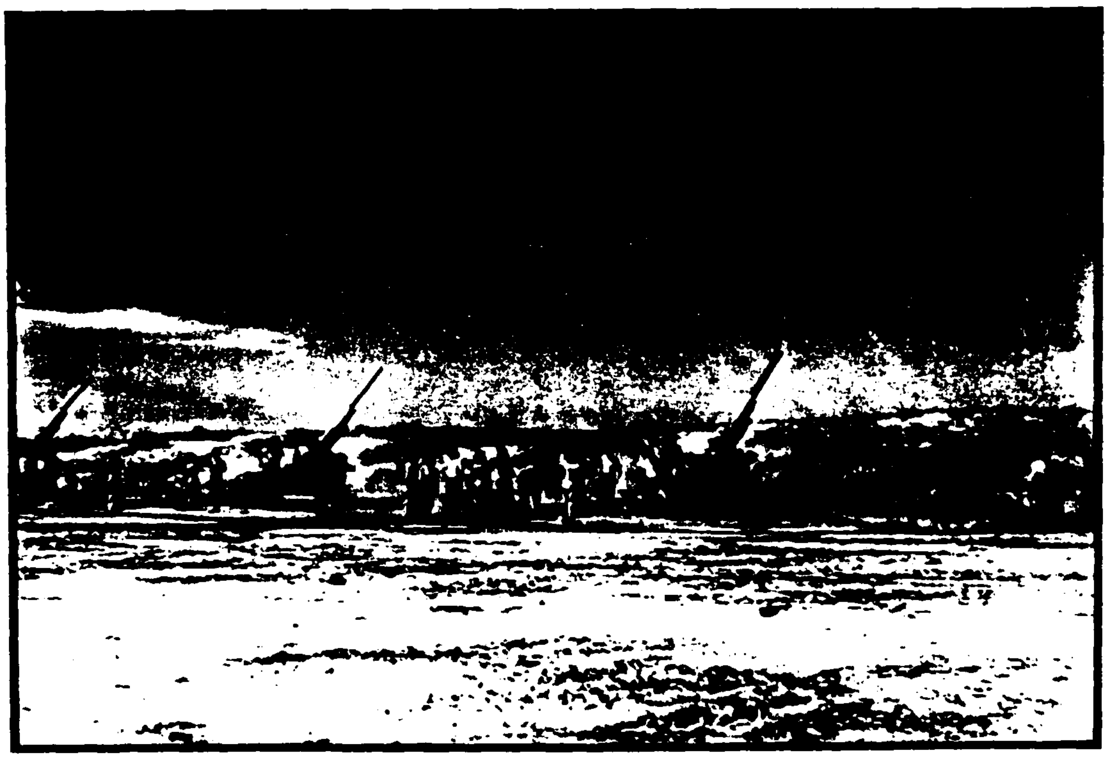

FIGURE 123 FIRING LINE, CAMP MALAKOLE (LEAF PHOTO 06)

Figures 124 & 125

These two pictures are nearly identical and represent a closely joined panoramic view of Camp Malakole and its firing line and are taken from almost the same position on the elevated sand dune.

Viewed from atop the massive sand dune fronting the ocean and overlooking the firing line in the previous gunnery pictures, an indepth cross-section of the entire camp may be seen here, looking <u>mauka</u> (eastward) toward Malakole Road and Waianae Range. Note the maximum utilization of the entire camp acreage to support its primary antiaircraft training mission. The firing line, fire direction center line, and utility area to the rear encompasses an enormous swath of cleared land that extends the entire length of the camp from north to south. The remainder of the 75.016 acres of deeded military reservation are assigned to the camp proper which utilized and retained wherever possible, the thick growht of <u>kiawe</u> trees for their shade, soil conservation, and the advantages of their natural camouflage. In the foreground are emplaced two spider mount, three-inch antiaircarft guns, their operating mechanism carefully protected from the elements and blowing sand by canvas tarpaulins. Aligned with the steel observation tower are various utility and pyramidal canvas tents for storage and miscellaneous purposes, needed during firing exerices. A motor pool and small gun park is at the viewers left rear of tower. Within the near fringe line of <u>kiawe</u> trees and equally accessible to the firing line and camp alike, extends a row of latrines and washroom/ shower facilities. The pitfalls experienced with the early septic tank disposal system is covered elsewhere in Colonel Bandel's excellent outline history of the camp. The remainder of the camp, comprising 112 total buildings, are well hidden beneath the thick <u>kiawe</u> cover. The one and the same battery street, visible in each picture, is restricted to vehicle traffic and a good example of others throughout the camp. Judging from the absence of camp activity it is obvious this photo was taken on a Sunday or rare holiday. The troops, emerging into the battery street and converging towards the gun emplacements, may be a swimming party headed for the beach (most likely), or members of a gun crew assigned to clean and tend their weapon (less likely).

(Leaf Photos #07 & #08)

FIGURE 124 OVERLOOKING THE FIRING LINE, CAMP MALAKOLE, PANORAMIC VIEW WITH FIGURE 125 (LEAF PHOTO 07)

FIGURE 125 OVERLOOKING THE FIRING LINE, CAMP MALAKOLE, PANORAMIC VIEW WITH FIGURE 124 (LEAF PHOTO 08)

Figure 126

Located on the main road entering Camp Malakole and adjacent to the newly constructed regimental headquarters building and tall flag pole, members of the massed 251st Coast Artillery (Antiaircraft) Regiment, Colonel John H. Sherman, Commanding, are formed in a line of battalions as they proudly stand to attention during an informal Retreat ceremony which honors the daily lowering of evening Colors at sunset. The Regimental Band provides appropriate accompaniment as the Colors are slowly hauled down from the peak. The artillerymen, wearing their best starched khaki, without arms, remain at attention while the officers and senior non-commissioned officers execute a hand salute. The rubbly camp area behind the formation has yet to be developed and constructed. The crossroad in the bottom right foreground meets at the first road intersection entering the camp.

(Bandel Photo #204)

Figure 127

Throughout history, military parades and ceremonies have always played a very important function in the development of soldierly pride and esprit de corps in a military organization. Here at Camp Malakole, along with their daily camp construction and training routines for digging ditches, driving nails, and firing antiaircraft weapons, these artilleryment of the 251st Coast Artillery (Antiaircraft) Regiment, marching in a column of batteries, stride smartly in review during a regimental parade. In the left foreground their regimental commander, Colonel John H. Sherman and his staff, stand at attention to receive the salute. That this is an early 1941 photo is indicated by the freshly cleared and leveled firing line (doubling as a parade ground) which accounts for the still uncleared rubble, the partially filled limestone sink, the swarming dust from marching boots, and the untrimmed and uncleared remnants of kiawe and other vegetative growth on the southern flank and seaward sand dune. Framed in the upper left, a lace-like tracery of kiawe boughs decorates this memorable scene.

(Bandel Photo #553)

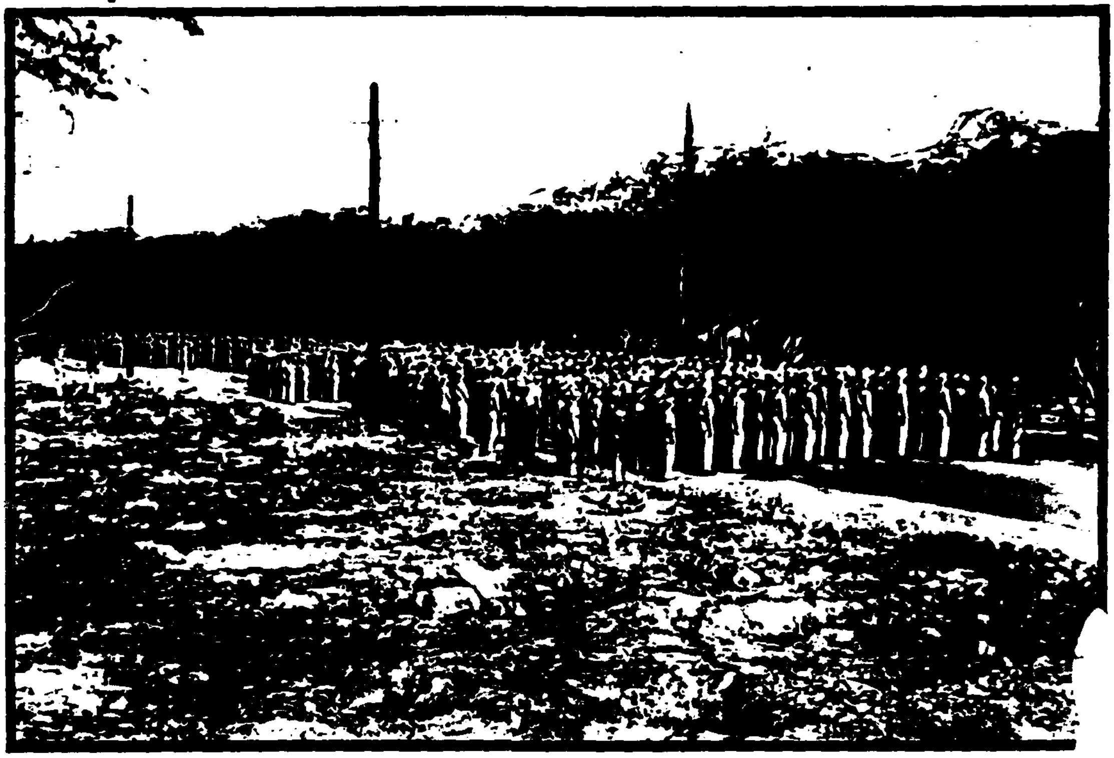

FIGURE 126 RETREAT CEREMONY, CAMP MALAKOLE (BANDEL PHOTO 204)

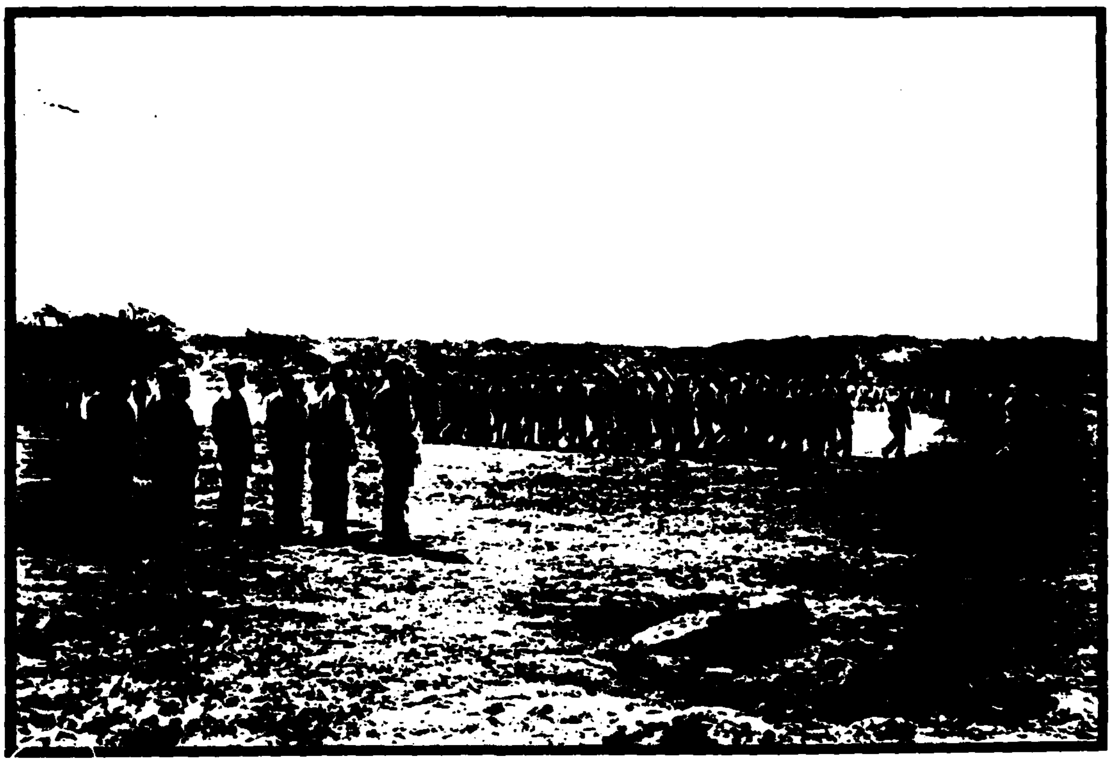

FIGURE 127 REGIMENTAL PARADE, CAMP MALAKOLE (BANDEL PHOTO 553)

Figure 128

At Camp Malakole, Battery A, Captain Melbourne H. West, Commanding, of the 1st Battalion, 251st Coast Artillery (Antiaircraft) Regiment was equipped with these pre-war high intensity multi-million candle-powered searchlights. Through decades of time they served a number of useful functions until outmoded by technology; they were replaced by radar soon after the outset of World War II in the Pacific. Note the slim, heavy steel disc wheels, non-pneumatic rubber tires, and simple leveling screw devices. These big lamps were probably transported aboard trucks for operational use. The two heavy trucks in the background are pre-war prime movers, possibly two and a half ton capacity, with heavy canvas tops over the cargo bed. The unidentified GI friends and neighbor in the background, are wearing three different types of pre-war uniforms, with the old-fashioned high top shoes. Soon after December 7, 1941, the demands of war mobilization ushered in a unified combat uniform for the armed forces, with rugged leather combat shoes or boots.

(Leaf Photo #024)

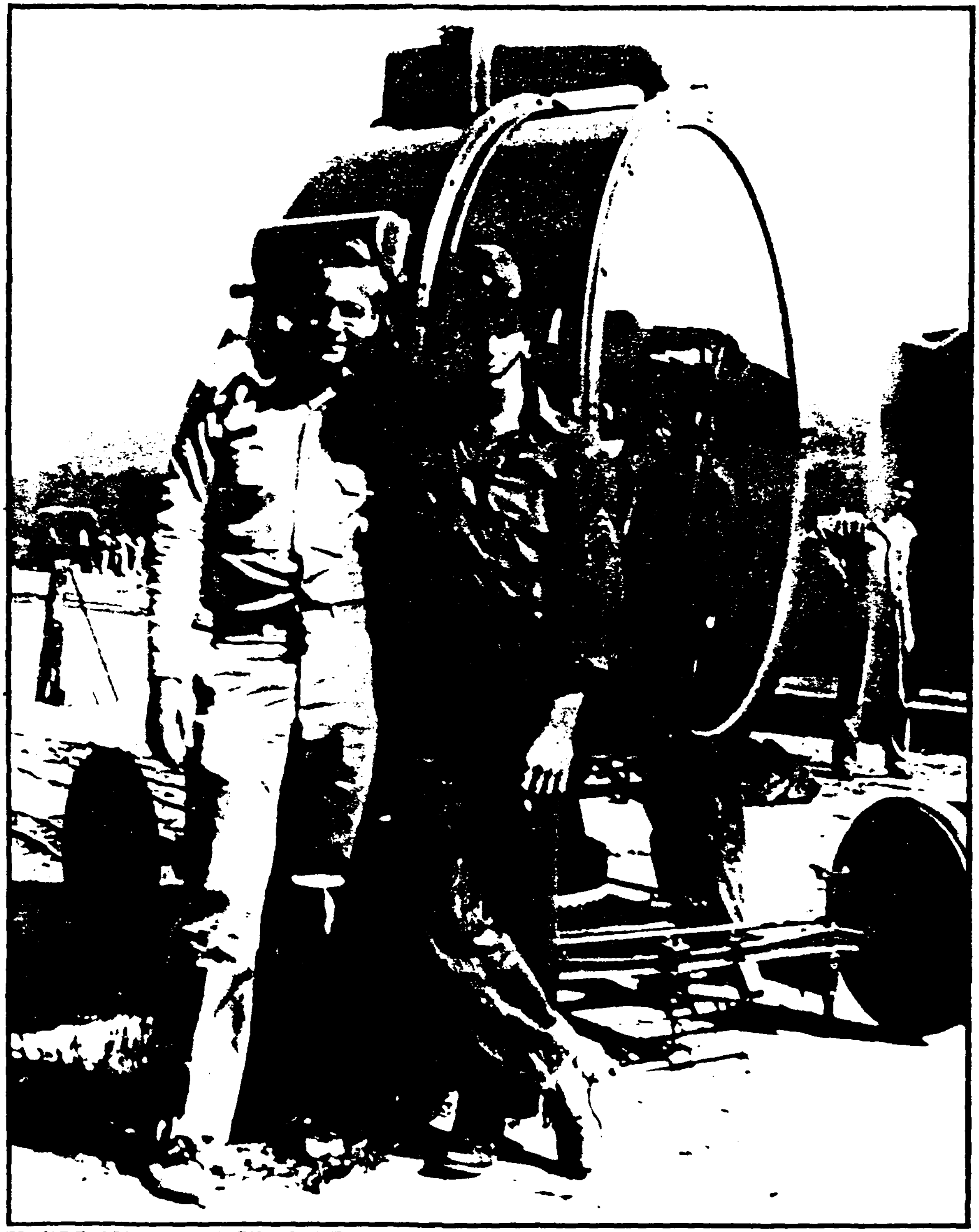

FIGURE 128 SEARCH LIGHT, CAMP MALAKOLE (LEAF PHOTO 024)

Figure 129

Marching along an 'Ewa roadside with a jaunty military cadence, a battery of troops from the 251st Coast Artillery (Antiaircraft) Regiment return to Camp Malakole from a field exercise problem. This photo appears to be taken in early 1941 since the recently mobilized Californians are still wearing their heavy OD (olive drab) uniforms, stiff-brim campaign hats, and a mixture of footwear of the peacetime national guard. The troops are equipped with their individual issue weapon carried at "Sling Arms" for greater comfort during long marches, and may be carried interchangeably over the right or left shoulder. Their rifle is a vintage piece - the World War I Model 1903, bolt action, 30 caliber Springfield rifle, renowned for its great accuracy when used by skilled marksmen. Sergeants and below, in rank, wear a rifle cartridge belt, bayonet and scabbard, first aid kit and canteen. Senior non-commissioned officers and officers wear a web pistol belt, Colt automatic pistol, 45 caliber, Model 1911 or 1911A1 and leather holster, web magazine carrier, canteen and first aid packet containing a gauze compress bandage. The specific location here is unidentified, however, the cleared grassy fields, thickets of vegetation and miscellaneous type buildings including the gutted and abandoned dwelling in the left foreground indicate a rural habitation area. Note the unpaved road surface and its generally unimproved characteristics of that era.

(Bandel Photo #H98)

Figure 130

Posted on a Camp Malakole rampart overlooking the then gentle swells of a peaceful Pacific Ocean, an artilleryman of the 251st Coast Artillery (Antiaircraft) Regiment momentarily stands silhouetted against the last fading rays of an O'ahu sunset. As an outpost of the camp's interior guard force, he is charged with that eternal first general order for all milita.·y sentinels "To walk my post in a military manner, keeping always on the alert, and observing everything that takes place within sight or hearing".

(Leaf Photo #021)

FIGURE 129 MARCHING ALONG AN 'EWA ROADSIDE (BANDEL PHOTO H98)

FIGURE 130 A LONE INTERIOR GUARD, CAMP MALAKOLE (LEAF PHOTO 021)

APPENDIX IV

TABLE 17

MASTER ARTIFACT CATALOG

Site	Accession Number	Trench	Level (cm.)	Stratum	Depth Below Surface (cm)	Grid Location	Feature Association	Code	Description	Lgth. (cm.)	Width (cm.)	Thick (cm.)	Weight (gm.)
2712	AR1	N3E3	0-10	I	0-10	NE	-	2	Rusty metal, can rim	5.66	0.49	0.30	2.0
2712	AR2	N3E3	0-10	I	0-10	NW	-	2	Cut bone, one end worked	2.28	1.23	0.52	1.2
2712	AR3	N1W2	0-10	I	1	NW/R10U100	-	1	Basalt flake	5.93	2.82	2.23	47.6
2712	AR4	N1W2	0-10	I	0	NW/R18U77	-	1	Coral file fragment	4.53	3.01	3.06	24.6
2712	AR5	N3W1	0-10	I	(Surface)	R37U69	-	1	Bullet clip (holder), metal	6.42	1.50	0.57	9.0
2712	AR6	N1W2	0-10	I		NW/R42U79	-	1	Coral file fragment	1.32	2.51	2.31	6.2
2712	AR7	N1W2	0-10	I	0	NE/R53U59	-	1	Coral file fragment	2.30	3.48	2.57	11.9
2712	AR8	N2W3	0-10	I	0-10	SE	-	2	Coral file fragment	2.10	1.09	0.92	1.3
2712	AR9	N2W2	0-10	I	2	NW/R22U82	-	1	Coral file	3.27	1.38	1.21	3.6
2712	AR10	N4W1	0-10	I/II	0-10	SW	-	2	2-Piece fishhook point, bone	3.80	0.60	0.30	1.1
2712	AR11	N3W2	0-10	I	1	SE/R78U12	-	1	Lava abrader, basalt	7.44	4.93	3.75	107.5
2712	AR12	N4W1	0-10	I/II	0-10	NE	-	2	Worked pearl shell	1.16	0.77	0.12	0.4
2712	AR13	N4W1	0-10	I/II	0-10	NE	-	2	Incised bone, fragment	2.85	0.67	0.30	1.0
2712	AR14	N3W1	0-10	I	0-5	All	-	3	Bullet shell casing, .30 cal., brass	6.31	-	1.18	12.5
2712	AR15	N3W1	0-10	I	Surface	SW/R28U47	-	1	Bullet shell casing, .30 cal., brass	6.31	-	1.19	12.5
2712	AR16	N3W1	Surface	I	-	NW/R35U98	-	1	Bullet shell casing, .30 cal., brass	6.31	-	1.18	12.5
2712	AR17	N3W1	Surface	I	-	SW/R34U40	-	1	Bullet clip (holder), .30 cal.	6.21	1.50	-	9.0
2712	AR18	N2W2	0-10	I/II	10	NW/R19U87	-	1	Coral file fragment	1.99	1.81	1.53	5.4
2712	AR19	N3W3	0-10	I/II	5	NE/R90U92	-	1	Coral saw fragment	2.59	1.90	2.90	5.4
2712	AR20	N2W2	10-20	II	10-20	NE	-	2	Coral file fragment	4.38	2.41	2.19	13.9
2712	AR21	N2W2	10-20	II	10-20	SE	-	2	Coral file fragment	2.50	1.29	0.55	1.1
2712	AR22	N2W2	10-20	II	10-20	SW	-	2	Coral file fragement	3.03	-	1.31	3.8
2712	AR23	N2W2	10-20	II	10-15	NW	-	2	Worked bone, partially burnt	2.84	0.98	0.43	1.4
2712	AR24	N2W2	10-20	II	10-15	NW	-	2	Coral file fragment	1.73	1.59	1.30	3.1
2712	AR25	N2W2	10-20	II	10-20	SW	-	2	Coral file fragment	4.80	1.87	1.24	6.1
2712	AR26	N2W2	10-20	II	15-20	NW	-	2	Coral file fragment	1.58	1.81	0.80	2.0
2712	AR27	N2W2	10-20	II	15-20	NW	-	2	Worked bone	2.89	1.00	0.56	1.2
2712	AR28	N2W2	10-20	II	15-20	NW	-	2	Worked bone	1.74	0.56	0.22	0.6
2712	AR29	N2W2	10-20	II	15-20	NW	-	2	Flake, basalt	5.71	2.79	1.69	37.9
2712	AR30	N2W2	10-20	II	10-20	SW	-	2	Coral file fragment	3.37	1.44	0.91	4.2
2712	AR31	N2W2	10-20	II	10-20	NE	-	2	Fishhook bend, bone, burnt	-	0.40	0.28	0.4
2712	AR32	N2W2	10-20	II	10-20	SE	-	2	Utilized basalt flake	5.65	3.30	1.25	28.8
2712	AR33	N3E2	10-20	II	10-20	SW	-	2	Coral file fragment	1.49	0.80	0.61	1.0
2712	AR34	N2W2	10-20	II	10-20	NW	-	2	Basalt abrader fragment	7.59	4.41	3.25	101.4
2712	AR35	N2W1	0-10	II	5-10	NE	-	2	Composite fishhook point, bone, notched	5.30	0.57	0.49	1.6
2712	AR36	N3W1	0-10	II	5-10	All	-	3	One-piece fishhook fragment, point and bend, bone; repaired with AR#40	1.60	0.30	0.26	0.5
2712	AR37	N2W1	30-40	II	30-40	NE	-	2	Worked pearl shell	1.56	1.26	0.10	0.6
2712	AR38	N5W1	22-32	II	22-27	sink	-	2	One-piece fishhook, preform fragment, bone perforated	1.11	0.70	0.29	0.6
2712	AR39	N3E1	0-10	II	5-10	SE	-	2	Broken perforated fishhook blank, bone	2.52	0.64	0.31	0.5
2712	AR40	N3W1	10-20	II	14	SE/R16U8	-	1	Fishhook fragment, shank and head, bone, repaired with AR #36	2.41	0.31	0.30	0.6

Note: Mixing at stratigraphic boundaries is indicated by dual stratum designation, i.e., I/II or II/III.

Site	Accession Number	Trench	Level (cm.)	Stratum	Depth Below Surface (cm)	Grid Location	Feature Association	Code	Description	Lgth. (cm.)	Width (cm.)	Thick (cm.)	Weight (gm.)
2712	AR41	N3W1	10-20	II	12	NE/R79U53	-	1	Fishhook fragment, shank and head, bone	1.79	0.25	0.24	0.5
2712	AR42	N3W1	10-20	II	10-20	SE	-	2	Cut bone fragment	1.69	0.81	0.46	0.8
2712	AR43	N3W1	10-20	II	10-20	SE	-	2	Coral file fragment	1.88	1.41	0.89	2.5
2712	AR44	N2W1	30-40	II	30-40	NW	-	2	Worked bone	1.34	0.69	0.35	0.6
2712	AR45	N5W2	20-40	II	20-40	NE/R89U65	-	1	Fishhook blank, bone	1.28	0.97	0.25	0.9
2712	AR46	N3E1	0-10	II	5-10	SW	-	2	Fishhook preform fragment, bone	1.55	0.45	0.20	0.4
2712	AR47	N3W3	0-10	II	5	NE/R82U90	-	1	Turtle shell, net gauge	9.35	4.26	0.60	18.3
2712	AR48	N3W3	0-10	II	6	NE/R84U77	-	1	Coral abrader fragment	1.67	3.44	2.79	7.7
2712	AR49	N3E1	10-20	II	10-15	SW	-	2	Coral file fragment	0.89	-	0.19	1.3
2712	AR50	N3W3	10-20	II	10-20	SE	-	2	Coral file tip fragment	1.84	-	0.57	1.0
2712	AR51	N3E1	0-10	II	5-10	NE	-	2	Coral file fragment	1.55	1.31	0.74	1.2
2712	AR52	N3E1	0-10	II	5-10	NW	-	2	Coral file fragment	1.12	-	0.77	0.8
2712	AR53	N3W2	10-20	II	10-20	SW	-	2	Coral file tip	1.62	-	1.01	1.1
2712	AR54	N2W1	10-20	II	18	NE/R52U93	-	1	Coral file tip	2.33	-	1.57	2.9
2712	AR55	N3W1	10-20	II	13	SW/R32U14	-	1	Coral file fragment	2.96	-	1.76	3.4
2712	AR56	N2W1	10-20	II	12	NE/R60U95	-	1	Coral file	2.84	-	0.93	1.7
2712	AR57	N3W3	0-10	II	5-10	SW	-	2	Coral file fragment	2.32	-	1.59	3.1
2712	AR58	N2W1	10-20	II	11	NE/R78U88	-	1	Coral file	2.35	1.28	0.83	1.8
2712	AR59	N3W1	10-20	II	19	SE/R62U30	-	1	Coral file	3.94	1.33	1.15	4.2
2712	AR60	N3W2	0-10	II	0-5	NE	-	2	Bullet shell casing, brass	6.28	-	1.15	12.7
2712	AR61	N3W2	0-10	II	6	SE	-	1	Coral file	3.72	1.88	1.41	6.4
2712	AR62	N3W2	0-10	II	0-5	NW	-	2	Bullet shell casing, brass	6.28	-	1.15	12.4
2712	AR63	N3W2	0-10	II	0-5	NW	-	2	Coral saw	4.15	2.91	1.26	4.9
2712	AR64	N2E1	10-15	II	10-15	SW	-	2	Drill-bit, shell columnella	4.94	0.70	0.64	2.5
2712	AR65	N1E2	10-20	II	10-17	NE	-	2	Cut pearl shell fragments, (2)	1.41	0.66	0.11	0.2
2712	AR66	N1E2	0-5	I/II	3	NW	-	2	File fragment, coral	2.90	1.05	1.02	2.3
2712	AR67	N1E2	0-5	I/II	3	NW	-	2	Coral file fragment	1.36	1.00	0.70	0.6
2723	AR68	N1E1	0-10	I	0-10	SW	-	2	Possible cut shell	2.01	0.99	0.20	0.5
2723	AR69	N1E1	0-10	I	0-7	SW	-	2	Possible cut shell	2.49	1.80	0.31	2.0
2723	AR70	N1E1	10-20	II	10-15	SW	-	2	Coral file fragment	1.93	1.20	1.86	1.7
2723	AR71	N1W2	0-10	I	3-10	NE	-	2	Possible worked pearl shell fragments, (2)	1.37	0.93	0.19	0.4
2723	AR72	N1W2	0-10	I	3-10	NW	-	2	Possible cut shell	2.31	1.39	0.25	1.2
2723	AR73	N1E1	0-10	I	surface	NW/R12U99	-	1	Coral file fragment	1.51	1.41	1.51	2.2
2723	AR74	S2W1	0-10	II	6-10	All	-	3	Shell fragment	1.79	1.00	0.17	0.2
2723	AR75	S2W1	0-10	II	3	NE/R74U54	-	1	Limestone flake awl	6.81	5.41	1.65	88.1
2723	AR76	N1W3	0-10	I	3-10	SE	-	2	Fishhook blank, bone	1.55	1.36	0.33	0.4
2723	AR77	S1W1	0-10	I	0-6	NW	-	2	Coral file fragment	1.80	1.76	1.14	2.8
2723	AR78	S1W1	0-10	I	3-10	All	-	3	Worked shell	2.59	2.37	0.25	1.2
2723	AR79	N1W1	0-10	I	3-10	NE	-	2	Coral abrader fragment	1.81	1.31	0.90	1.2
2723	AR80	N1W1	10-20	II	10-20	NE	-	2	Worked shell	1.79	1.81	0.40	1.0
2723	AR81	N1W1	20-30	II	20-30	SE	-	2	Worked shell	1.31	0.87	0.11	0.2
2730	AR82	N1W2	0-5	I	0-5	NE	-	2	Two-Piece Bone fishhook point blank	3.55	0.79	0.39	1.0
2730	AR83	N1W2	5-10	I	5-10	NW	-	2	Cut bone fragment (pig femur)	4.81	4.03	1.77	18.0
2730	AR84	N1W2	5-10	I	5-10	SE	-	2	Worked bone	0.81	2.34	0.74	1.0
2730	AR85	N1W1	0-5	I	0-5	SW	-	2	Coral file	2.90	1.41	0.85	3.3
2730	AR86	N1W1	0-5	I	3	SE/R74U9	-	1	Coral file fragment	2.91	1.84	0.94	4.0
2730	AR87	N1W3	0-5	I	5	NE/R64U57	-	1	Coral file fragment	2.57	1.69	1.29	4.0
2731	AR88	N1E1	5-10	II	5-10	NW	-	2	Basaltic glass, 1 piece	1.93	1.40	0.60	2.1
2731	*AR89	S1E1	5-10	II	5-10	SW	-	2	Basaltic glass, 2 pieces	1.00-1.35	0.77-1.20	0.27-0.36	1.0
2731	AR90	S1E1	5-10	II	5-10	SW	-	2	Coral file tip fragment	1.35	0.78	0.50	0.4

*Basaltic glass submitted for dating.

Site	Accession Number	Trench	Level (cm.)	Stratum	Depth Below Surface (cm)	Grid Location	Feature Association	Code	Description	Lgth. (cm.)	Width (cm.)	Thick (cm.)	Weight (gm.)
2731	AR91	S1E1	5-10	II	5-10	NE	-	2	Coral file fragment	3.11	1.60	0.66	2.3
2731	AR92	S1E1	5-10	II	5-10	NE	-	2	Coral file tip fragment	1.85	0.90	0.73	0.8
2731	AR93	S1W1	10-20	II	18	SE/R99U16	-	1	Coral file fragment	2.95	1.64	1.10	4.7
2731	AR94	N1E2	0-5	I	4	NW/R2U72	-	1	Porites coral pebble fragment	5.14	4.13	3.57	40.7
2731	AR95	N1E2	5-10	I/II	5-10	SW	-	2	Shell fishhook blank	1.46	1.43	0.37	0.3
2731	AR96	N2W1	5-10	II	5-10	NE	-	2	Shell fishhook blank	1.46	1.16	0.17	0.3
2731	AR97	S1E1	10-15	II	10-15	SW	-	2	Shell fishhook fragment	1.45	0.92	0.20	0.2
2731	AR98	S1E1	10-20	I	10-20	NE	-	2	Shell fishhook fragment	1.52	0.25	0.17	0.2
2731	AR99	S1E1	10-20	I	10-20	NE	-	2	Shell fishhook fragment	0.71	0.61	0.11	0.2
2731	AR100	S1W1	0-10	II	10	SE/R97U23	-	1	Bone fishhook	2.43	1.38	0.34	0.6
2731	AR101	N1E1	5-10	II	5-10	NE	-	2	Coral file tip	0.80	0.46	0.26	0.1
2731	AR102	N1E1	5-10	II	5-10	NE	-	2	Coral file fragment	1.80	1.06	0.61	1.0
2731	AR103	N1E1	5-10	II	5-10	NE	-	2	Coral file fragment	1.37	1.24	1.19	1.5
2731	AR104	N1E1	5-10	II	5-10	NE	-	2	Coral file fragment	2.14	0.83	0.54	0.5
2731	AR105	N1E1	5-10	II	5-10	NE	-	2	Coral file fragment	2.39	1.51	1.01	3.4
2731	AR106	N1E1	5-10	II	5-10	NE	-	2	Hematite flake, 1 piece	2.59	2.00	1.10	8.1
2731	AR107	N1E1	5-10	II	5-10	NE	-	2	Hematite flake, 1 piece	1.29	1.01	0.61	0.9
2731	AR108	N1E1	0-5	I/II	0-5	NE	-	2	Coral file fragment	1.70	1.73	0.74	1.7
2731	AR109	N1E1	5-10	II	5-10	SE	-	2	Cut shell (Tellina palatum)	1.71	1.22	0.18	0.4
2731	AR110	N1E1	15-25	II	15-25	NE	-	2	Coral saw fragment	4.23	1.61	0.81	4.1
2731	AR111	N1E1	5-10	II	5-10	NW	-	2	Shell fishhook fragment (point barb)	0.78	0.43	0.10	0.1
2731	AR112	N1E1	10-15	II	10-15	NW	-	2	Shell one-piece fishhook fragment; shank, bend, point shank	0.80	0.60	0.10	0.1
2723	AR113	-	surface	I	surface	loc. on map	-	4	Metal tea pot with cover	24.28	12.11	11.82	416.9
2731	AR114	S1W1	0-20 clean-up	I	0-20 clean up	All	-	3	Shell fishhook fragment, shank & head	1.45	0.54	0.23	0.4
2731	AR115	S1W1	0-10	II	5	SW/R3U45	-	1	Coral file	3.26	1.50	1.09	4.0
2731	AR116	S2W1	5-10	II	5-10	NW	-	2	Shell fishhook shank fragment	1.43	0.42	0.16	0.2
2731	AR117	S1E2	10-20	II	10-20	SW	-	2	Shell fishhook, 1 piece, head & shank fragment	1.67	0.25	0.14	0.2
2731	AR118	N1E2	15-20	II	15-20	SW	-	2	Shell one-piece fishhook, head and shank	1.64	0.35	0.20	0.2
2730	AR119	-	surface	I	surface	loc. on map	-	1	Coral ulu maika fragment	7.60	7.00	2.68	108.4
2730	AR120	S1W3	4	I/II	4	NE/R68U98	-	1	Coral file	3.40	1.57	1.29	3.9
2731	AR121	S1E2	10-20	II	11	NE/R86U60	-	1	Coral abrader	9.15	2.36	1.90	38.7
2731	AR122	S1E2	10-20	II	12	NW/R18U86	-	1	Coral file fragment	3.97	2.07	1.82	9.7
2731	AR123	S1E2	0-10	II	6	SE/R88U11	-	1	Coral file fragment	1.57	1.03	0.76	1.0
2731	AR124	S1E2	10-20	II	12	NW/R42U90	-	1	Coral file fragment	4.11	1.38	1.01	4.8
2731	AR125	S1E2	10-20	II	10	NW/R12U98	-	1	Cut shell scaper or knife	3.11	2.27	0.21	2.4
2731	AR126	S1E2	10-20	II	14	NW/R7U81	-	1	Cut shell fragments, 3 pieces	2.84	0.99	0.16	1.7
2731	AE127	S1E2	10-20	II	10	NW/R13U72	-	1	Cut bone	5.80	3.71	0.46	7.6
2731	AR128	S1E2	10-20	II	10-20	All	-	3	Coral saw fragment	3.47	2.81	0.99	8.9
2731	AR129	S1E2	10-20	II	10-20	SW	-	2	Coral file	3.37	1.26	0.61	2.5
2731	AR130	S1E2	10-20	II	10-20	SW	-	2	Coral file tip	1.87	0.67	0.36	0.4
2731	AR131	S1E2	10-20	II	11	NW/R24U78	-	1	Coral saw	6.77	1.90	1.03	14.3
9682	AR132	N2E1	0-5	I/II	0-5	NE	-	2	Amber Bottle glass fragments, 2 pieces	2.73	1.35	0.30	2.3
9682	AR133	N1E1	0-10	I	0-10	SE	-	2	Basaltic glass, 3 pieces	1.22-1.30	0.78-0.91	0.52-0.66	3.1
9682	AR134	N1E1	0-10	I	0-10	NW	-	2	Basaltic glass, 2 pieces	0.86-0.94	0.57-0.74	0.34-0.49	0.6

Site	Accession Number	Trench	Level (cm.)	Stratum	Depth Below Surface (cm)	Grid Location	Feature Association	Code	Description	Lgth. (cm.)	Width (cm.)	Thick (cm.)	Weight (gm.)
9682	AR135	N1E1	0-10	I/II	0-10	NE	-	2	Coral file	4.21	1.97	1.06	5.6
9682	AE136	N1E1	0-10	I/II	0-10	NE	-	2	Coral file fragment	2.35	1.23	1.13	2.4
9682	AR137	N1E1	0-10	I/II	0-10	NE	-	2	Coral file fragment	3.94	1.44	0.93	3.0
9682	AR138	N1E1	0-10	I/II	0-10	NE	-	2	Cut bone	1.46	1.00	0.37	0.5
9682	AR139	N1E1	0-10	I/II	0-10	NE	-	2	Cut bone	3.74	0.98	0.45	1.0
9682	*AR140	N1E1	0-10	I/II	0-10	NE	-	2	Basaltic glass, 1 piece	1.52	1.39	0.39	0.7
9682	AR141	N2E1	0-10	I/II	2	SW/R30U40	-	1	Coral saw	9.08	4.80	2.10	56.5
9682	AR142	N2E1	5-10	I	5-10	NE	-	2	Amber bottle glass fragment	3.00	3.10	0.16	2.1
9682	AR143	N2E1	5-10	I	5-10	NW	-	2	Amber bottle glass fragments, 3 pieces	4.16	1.01	0.21	2.4
9682	AR144	N1E1	10-20	II	10-20	SW	-	2	Basaltic glass, 1 piece	1.00	0.90	0.60	0.5
9682	AR145	N1E1	10-20	II	10-20	SW	-	2	Bone fishhook fragment, point	1.57	0.53	0.34	0.3
9682	AR146	N1E1	10-20	II	10-20	SE	-	2	Basaltic glass, 6 pieces	0.50-1.15	0.36-0.74	0.15-0.39	1.4
9682	AR147	N1E1	10-20	II	10-20	SE	-	2	Cut bone	2.90	1.46	0.41	1.2
9682	AR148	N1E1	10-20	II	10-20	SE	-	2	Cut bone	1.24	0.81	0.22	0.2
9682	AR149	N1E1	10-20	II	10-20	SE	-	2	Cut bone	1.17	0.47	0.21	0.1
9682	AR150	N1E1	10-20	II	10-20	SE	-	2	Coral file fragment	1.45	1.11	0.47	0.6
9682	AR151	-	10-20	I	15	loc. on map	-	4	[illegible] wood fragment	12.56	2.51	2.51	38.8
9682	AR152	-	-	In wall	15	loc. on map	-	4	Wire fragment, metal	14.73	2.49	0.37	23.9
9682	AR153	N2W1	0-8	I/II	0-8	SE	-	2	Basaltic glass, 1 piece	1.01	0.60	0.31	0.3
9682	AR154	N2W1	0-8	I/II	0-8	SE	-	2	Cut bone	1.91	0.85	0.63	0.8
9682	AR155	N1W1	0-10	I/II	0-10	NW	-	2	Basaltic glass, 1 piece	0.95	0.85	0.40	0.4
9682	AR156	N1W1	0-10	I/II	0-10	NE	-	2	Basaltic glass, 1 piece	1.37	1.21	0.75	1.5
9682	AR157	N1W1	0-10	I/II	0-10	NE	-	2	Cut bone	4.66	0.94	0.98	2.0
9682	AR158	-	surface	I	surface	loc. on map	-	1	Amber glass bottle fragment, bottom of-	6.44	-	0.61	39.0
9682	AR159	N1W2	10-15	I/II	12	NW/R52U74	-	1	Coral abrader	7.05	2.80	1.78	20.9
9682	AR160	N2E1	10-15	II	10-15	SW	-	2	Basaltic glass, 1 piece	1.49	0.56	0.25	0.1
9682	*AR161	N2E1	10-15	II/III	10-15	NW	-	2	Basaltic glass, 2 pieces	0.94-1.31	0.81-1.33	0.34-0.35	0.8
9682	AR162	N1E1	10-20	I/II	10-20	NW	-	2	Basaltic glass, 3 pieces	0.95-1.51	0.61-0.71	0.40-0.62	2.1
9682	AR163	N1E1	10-20	I/II	10-20	NE	-	2	Basaltic glass, 6 pieces	0.78-1.11	0.51-0.65	0.36-0.28	1.0
9682	AR164	N1W1	10-20	I	10-20	NE	-	2	Basaltic glass 5 pieces	1.25-1.90	0.49-1.88	0.25-0.63	4.7
9682	AR165	N1W1	10-20	II	10-20	NW	-	2	Coral file	3.96	1.79	1.35	6.4
9682	AR166	N1W1	10-20	II	10-20	NE	-	2	Coral file fragment	2.11	1.61	1.49	2.9
9682	AR167	N1W1	10-20	II	10-20	NE	-	2	Basaltic glass, 5 pieces	0.87-1.30	0.70-1.15	0.49-0.69	3.0
9682	AR168	N1W1	10-20	II	10-20	SE	-	2	Shell fishhook fragment, 1 piece shank, bend point shank	1.21	0.38	0.19	0.1
9682	AR169	N1E1	20-24	II	20-24	NW	-	2	Basaltic glass, 1 piece	1.41	0.49	0.54	0.5
2763	AR170	N1E1	5-10	II	5-10	NE	-	2	Coral file	3.64	1.36	1.33	4.4
2763	AR171	N1E1	10-15	II	10-15	SW	-	2	Coral file fragment	2.44	0.83	0.61	1.1
2712	AR172	N1W2	0-10	I	0 cm	NW/R42U97	-	1	Coral file fragment	0.96	0.84	0.45	0.5
2712	AR173	N2W3	0-10	I	0-10	SE	-	2	Coral file fragment	2.21	1.10	0.86	1.7
2712	AR174	N2W3	0-10	I	0-10	SE	-	2	Coral file fragment	1.34	0.84	0.65	0.8
2712	AR175	N2W3	0-10	I	0-10	SE	-	2	Coral file fragment	1.40	0.94	0.92	1.1
2712	AR176	N2W3	0-10	I	0-10	SE	-	2	Coral file fragment	1.12	1.11	0.85	1.0
2712	AR177	N2W3	0-10	I	0-10	SE	-	2	Coral file fragment	1.00	1.12	0.62	0.9
2712	AR178	N3W1	0-10	I	0-5	All	-	3	Bullet shell casing, brass	6.31	-	1.18	12.5
2712	AR179	N2W2	10-20	II	10-20	NE	-	2	Coral file fragment	3.20	1.20	1.43	4.7
2712	AE180	N2W2	10-20	II	10-20	SE	-	2	Coral file fragment	1.47	0.70	0.45	0.7

Site	Accession Number	Trench	Level (cm.)	Stratum	Depth Below Surface (cm)	Grid Location	Feature Association	Code	Description	Lgth. (cm.)	Width (cm.)	Thick (cm.)	Weight (gm.)
2712	AR181	N2W2	10-20	II	20-20	SW	-	2	Coral file fragment	2.55	1.14	0.76	2.1
2712	AR182	N2W2	10-20	II	10-20	NW	-	2	Coral file fragment	1.21	1.79	1.58	3.4
2712	AR183	N2W2	10-20	II	10-20	NW	-	2	Coral file fragment	1.11	1.73	1.05	1.7
2712	AR184	N2W2	10-20	II	10-20	NW	-	2	Coral file fragment	1.50	1.55	0.63	1.6
2712	AR185	N2W2	10-20	II	10-20	NW	-	2	Coral file fragment	1.48	1.09	1.41	1.7
2712	AR186	N2W2	10-20	II	10-20	NW	-	2	Coral file fragment	1.88	1.50	1.50	2.9
2712	AR187	N2W2	10-20	II	10-20	NW	-	2	Coral file fragment	1.69	1.41	1.70	4.7
2712	AR188	N2W2	10-20	II	10-20	NW	-	2	Coral file fragment	1.37	1.38	0.65	1.1
2712	AR189	N2W2	10-20	II	10-20	SW	-	2	Coral file fragment	1.98	1.17	1.29	1.6
2712	AR190	N2W2	10-20	II	10-20	SW	-	2	Coral file fragment	1.59	1.14	0.91	1.0
2712	AR191	N2W2	10-20	II	10-20	SW	-	2	Coral file fragment	1.20	1.07	0.97	1.0
2712	AR192	N2W2	10-20	II	10-20	SW	-	2	Coral file fragment	1.00	1.21	0.90	0.9
2712	AR193	N3W2	0-10	II	0-5	NE	-	2	Bullet shell casing, brass	6.28	-	1.15	12.7
2712	AR194	N3W2	0-10	II	0-5	NE	-	2	Bullet shell casing, brass	6.28	-	1.15	12.7
2712	AR195	N3W2	0-10	II	0-5	NE	-	2	Bullet shell casing, brass	6.28	-	1.15	12.7
2712	AR196	N3W2	0-10	II	0-5	NE	-	2	Bullet clip (holder), brass	6.20	1.47	0.55	9.1
2712	AR197	N3W2	0-10	II	0-5	NE	-	2	Bullet clip (holder), brass	6.20	1.47	0.55	9.1
2712	AR198	N2E2	0-10	surface of II	0-2	NW	-	2	Pearl shell fishhook preform, perforated	1.63	1.15	0.19	0.1
2712	AR199	N2E2	0-10	II	2-4	SE	-	2	Cut pearl shell	1.86	1.16	0.15	0.1
2712	AR200	N4W3	0-10	I	0-5	SE	-	2	Coral file	3.27	1.11	0.82	1.8
2712	AR201	N4W2	0-10	I	0	SW	-	2	Bullet shell casing, brass	6.32	1.16	-	12.4
2712	AR202	N2E1	0-10	II	0-10	-	-	1	Bone fishhook preform	3.25	1.21	0.22	0.5
2712	AR203	S1E1	0-10	I	surface	NE/R100U70	-	1	Basalt hammerstone, broken	10.73	8.25	4.53	508.5
2712	AR204	S2W1	surface	I	surface	NW loc. on map	-	2	Fire cracked basalt, no wear	6.61	9.91	4.26	425.0
2712	AR205	S1E1	surface	I	surface	SE loc on map	-	2	Basalt flake	7.51	7.48	1.89	220.0
2712	AR206	N4W2	0-10	I	5	SW/R40U35	-	1	Basalt flake	4.97	3.98	1.01	26.7
2712	AR207	N2E2	10-20	II	10.5	NE/R60U99	-	1	Coral file fragment	2.75	1.52	0.97	1.6
2712	AR208	N2W4	0-8	I/II	2-5	SW	-	2	Worked limestone flake	4.45	4.43	1.38	26.9
2712	AR209	S1W2	0-10	I	0	NE/R66U64	-	1	Coral file fragment	4.01	2.14	1.74	9.5
2712	AR210	S1W1	0-10	II	6	NE/R87U97	-	1	Coral file fragment	1.91	1.09	0.94	1.2
2712	AR211	N2E1	0-10	II	0-5	NW	-	2	Cut shell (Isognomen)	2.87	2.04	0.29	2.0
2712	AR212	N5E1	6-16	II	6-16	SE	-	2	Adze flake, basalt, one polished surface	3.71	1.85	0.45	3.2
2712	AR213	S1W1	0-10	II	3-10	SE	-	2	Coral file fragment	0.95	0.60	0.39	0.2
2712	AR214	N4E1	0-10	II	0-10	SW	-	2	Coral file	3.14	1.45	1.13	3.8
2712	AR215	N2W4	0-8	I/II	2-5	W½	-	3	Coral file fragment	2.71	1.31	1.01	2.4
2712	AR216	N5E1	6-16	II	6-16	NE	-	2	Adze flake, basalt, one surface polished	3.87	2.04	0.31	3.1
2712	AR217	S1W2	surface	I	0 cm	NE/R50U65	-	1	Coral file fragment	1.61	1.10	0.70	0.9
2712	AR218	N2E1	10-20	II	10-20	NE	-	2	Cut bone	1.68	0.50	0.24	0.1
2712	AR219	S1E1	0-5	I	0-5	SW	-	2	Coral file fragment	1.91	1.44	0.89	2.1
2712	AR220	N5E1	0-10	I	2	NW	-	2	Sharpened bird(?) bone pick	3.94	0.87	0.56	1.0
2712	AR221	N2E1	10-20	II	10-12	NW	-	2	Bone fishhook blank	3.49	1.82	0.68	3.5
2712	AR222	S1E1	0-10	II	5-10	SE	-	2	Coral file tip	2.37	1.39	1.03	1.9
2712	AR223	N4W3	0-10	I	0-5	SE	-	2	Cut bone	2.05	1.22	0.26	0.5
2712	AR224	N5E2	in wall	I	+7	SW/R45U45	-	1	Worked limestone flake	7.28	5.31	2.23	71.6
2712	AR225	N4W2	0-10	II	3	SW/R40U40	-	1	Coral abrader	8.84	3.71	3.70	91.0
2712	AR226	N4W2	0-10	II	5-10	SW	-	2	Cut bone	1.50	1.34	0.30	0.3
2712	AR227	N4W2	0-10	II	5	SW/R17U40	-	1	Limestone core, flaked	7.66	6.64	4.45	203.6
2712	AR228	N1W2	30-50	I	30-50	sink fill	-	3	Coral saw	5.45	3.00	1.33	15.1
2712	AR229	N1W2	30-50	I	30-50	sink fill	-	3	Coral file fragment	2.01	2.30	2.20	7.2
2712	AR230	N1W2	30-50	I	30-50	sink fill	-	3	Coral file fragment	4.14	1.64	1.29	3.5
2712	AR231	N1W2	30-50	I	30-50	sink fill	-	3	Coral file fragment	3.64	1.41	1.07	3.8

Appendix IV Table 17: Master Artifact Catalog (continued)

Site	Accession Number	Trench	Level (cm.)	Stratum	Depth Below Surface (cm)	Grid Location	Feature Association	Code	Description	Lgth. (cm.)	Width (cm.)	Thick (cm.)	Weight (gm.)
2712	AR232	N1W2	30-50	I	30-50	sink fill	-	3	Coral file fragment	2.79	1.50	1.21	3.2
2712	AR233	N1W2	30-50	I	30-50	sink fill	-	3	Coral file fragment	3.22	1.21	0.95	2.6
2712	AR234	N1W2	30-50	I	30-50	sink fill	-	3	Coral file fragment	2.19	1.48	0.79	1.9
2712	AR235	N1W2	30-50	I	30-50	sink fill	-	3	Coral file fragment	0.93	0.92	0.55	0.2
2712	AR236	N2E1	0-5	I	0-5	SW	-	2	Coral file fragment	2.40	1.35	1.15	2.5
2712	AR237	N2E1	0-5	I	0-5	SW	-	2	Coral file fragment	1.99	1.32	0.65	1.2
2712	AR238	N1W2	50-65	I rubble fill	50-65	sink fill	-	3	Coral file fragment	2.85	1.93	1.60	6.0
2712	AR239	N1W2	50-65	I rubble fill	50-65	sink fill	-	3	Coral file fragment	2.51	1.81	1.44	4.1
2712	AR240	N1W2	50-65	I rubble fill	50-65	sink fill	-	3	Coral file fragment	2.28	1.61	1.41	3.5
2712	AR241	N1W2	50-65	I rubble fill	50-65	sink fill	-	3	Coral file fragment	1.10	0.76	0.66	0.3
2712	AR242	S1W1	0-10	II	3-10	SW	-	2	Coral file fragment	1.51	0.81	0.59	0.5
2712	AR243	S1W1	0-10	II	3-10	SW	-	2	Coral file fragment	1.15	0.67	0.50	0.2
2712	AR244	S1W1	0-10	II	3-10	SW	-	2	Worked bone, burnt	0.99	0.66	0.34	0.2
2712	AR245	N1W2	65-70	II	65-70	sink fill	-	3	Coral file tip fragment	2.70	1.61	0.91	2.5
2712	AR246	N1W2	65-70	II	65-70	sink fill	-	3	Coral file tip fragment	3.00	1.25	1.00	2.6
2712	AR247	N1W2	65-70	II	65-70	sink fill	-	3	Coral file tip fragment	2.10	1.22	0.50	0.8
2712	AR248	N1W2	65-70	II	65-70	sink fill	-	3	Coral file tip fragment	1.39	1.02	0.79	0.6
2712	AR249	N1W2	65-70	II	65-70	sink fill	-	3	Coral file tip fragment	1.50	0.69	0.65	0.3
2712	AR250	N4E1	0-10	II	0-10	NW	-	2	Cut bone	1.61	0.99	0.23	0.4
2712	AR251	N4E1	0-10	II	0-10	NW	-	2	Cut bone	1.27	0.71	0.31	0.2
2712	AR252	N4E1	0-10	II	0-10	NW	-	2	Cut bone	1.04	0.73	0.19	0.1
2712	AR253	N4E1	0-10	II	0-10	SW	-	2	Coral saw fragment	2.63	2.33	1.70	5.8
2712	AR254	N4E1	0-10	II	0-10	SW	-	2	Coral file fragment	1.99	1.15	1.04	1.6
2712	AR255	N4E1	0-10	II	0-10	SW	-	2	Coral file fragment	1.67	1.16	0.94	1.0
2712	AR256	N4E1	0-10	II	0-10	SW	-	2	Coral file fragment	1.67	[illegible]	0.50	0.3
2712	AR257	N4E1	0-10	II	0-10	SW	-	2	Coral file tip fragment	0.78	0.62	0.32	0.1
2712	AR258	N4E1	0-10	II	0-10	SW	-	2	Shell fishhook blank	2.19	2.03	0.28	1.9
2778	AR259	S3W1	10-15	II/III	10-15	NE	-	2	Cut bone	1.37	0.68	0.34	0.2
2778	AR260	S1W2	5-10	II	5-10	SW	-	2	Bone fishhook shank	1.38	0.34	0.26	0.1
2778	AR261	S2W2	5-10	II	5-10	SE	-	2	Cut bone	1.13	0.77	0.26	0.4
2777	AR262	N1W3	5-10	II	5-10	SE	-	2	Coral file fragment	1.69	1.00	0.59	0.7
2777	AR263	N1W3	5-10	II	5-10	SE	-	2	Cut shell, fishhook blank?	0.99	0.60	0.13	0.2
2777	AR264	N1W3	5-10	II	5-10	SE	-	2	Cut shell, possible fishhook blank	1.62	0.83	0.16	0.3
2777	AR265	N1W3	5-10	II	5-10	NW	-	2	Cut shell, possible fishhook blank	1.14	0.85	0.14	0.2
2777	AR266	N1W3	5-10	II	5-10	NW	-	2	Cut shell, possible fishhook blank	1.63	1.10	0.20	0.4
2777	AR267	N1W3	5-10	II	5-10	NW	-	2	Cut shell, possible fishhook blank	1.58	1.01	0.21	0.4
2777	AR268	N1W1	5-10	II	5-10	All	-	3	Shell fishhook	1.41	0.71	0.19	0.1
2777	AR269	S1W3	10-15	II	10-15	NW	-	2	Coral file tip fragment	3.46	1.77	0.92	4.3
9682	AR270	S2W1	0-10	II	0-10	SW	-	2	Basaltic glass, 2 pieces	0.82-1.0	0.71-0.81	0.30-0.49	0.7
9682	*AR271	S1W2	10-20	II	10-20	SE	-	2	Basaltic glass, 3 pieces	0.95-1.25	0.48-0.87	0.49-0.51	1.1
9682	*AR272	S2W1	25-30	II feature	25-30	SW	-	2	Basaltic glass, 3 pieces	1.17-1.50	0.74-1.00	0.43-0.53	2.2
9682	*AR273	S2W1	10-20	II	10-20	NW	-	2	Basaltic glass, 5 pieces	1.43-1.16	0.69-1.07	0.19-0.79	4.1
9682	*AR274	S2W1	15-20	II	15-20	SE	-	2	Basaltic glass, 1 piece	0.84	0.92	0.24	0.2
9682	AR275	S2W1	10-15	II	10-15	NE	-	2	Basaltic glass, 6 pieces	0.74-1.69	0.70-0.96	0.25-1.14	5.4

Site	Accession Number	Trench	Level (cm.)	Stratum	Depth Below Surface (cm)	Grid Location	Feature Association	Code	Description	Lgth. (cm.)	Width (cm.)	Thick (cm.)	Weight (gm.)
9682	AR276	S2W1	0-10	II	0-10	SE	-	2	Basaltic glass, 5 pieces	0.66- 1.37	0.37- 1.10	0.30- 0.68	2.0
9682	*AR277	S2W1	10-15	II	10-15	SE	-	2	Basaltic glass, 1 piece	1.06	0.91	0.20	0.2
9682	*AR278	S2W1	0-10	II	0-10	NW	-	2	Basaltic glass, 4 pieces	1.04- 1.41	0.67- 0.92	0.23 0.49	1.9
9682	AR279	S2W1	10-20	II	10-20	SW	-	2	Basaltic glass, 2 pieces	1.03- 1.29	0.71- 0.87	0.18- 0.42	0.6
9682	AR280	S2W1	0-10	II	0-10	NE	-	2	Basaltic glass, 1 piece	1.37	0.51	0.44	0.4
9682	*AR281	S2W1	20-25	II feature	20-25	SW	-	2	Basaltic glass, 7 pieces	0.74- 0.96	0.57- 0.76	0.21- 0.25	1.0
9682	AR282	S1W2	0-10	I/II/III	0-10	W½	-	3	Basaltic glass, 1 piece	1.07	0.64	0.30	0.2
9682	AR283	S2E1	0-15	II/III	10-15	NE	-	2	Basaltic glass, 1 piece	1.31	1.07	0.39	0.6
9682	AR284	S1W1	10-20	II	10-20	NW	-	2	Basaltic glass, 1 piece	2.35	1.49	1.11	4.2
9682	*AR285	S3E1	10-20	II	10-20	NW	-	2	Basaltic glass, 2 pieces	0.84- 1.91	0.62- 1.18	0.14- 0.38	1.0
9682	AR286	S2E1	5-10	II	5-10	NE	-	2	Basaltic glass, 1 piece	1.02	0.95	0.75	0.9
9682	AR287	S1W1	10-20	II	10-20	SW	-	2	Basaltic glass, 2 pieces	0.79- 1.28	0.40- 0.61	0.29- 0.16	0.3
9682	AR288	S2E1	5-10	II	5-10	SW	-	2	Basaltic glass, 1 piece	0.81	0.56	0.40	0.3
9682	AR289	S2E1	5-10	II	5-10	SW	-	2	Basaltic glass, 1 piece	0.91	0.83	0.24	0.2
9682	*AR290	S1W2	0-10	I/II	0-10	E½	-	3	Basaltic glass, 2 pieces	0.71- 1.16	0.61- 0.61	0.30- 0.37	0.5
9682	AR291	S1W1	10-20	II	10-20	All	-	3	Basaltic glass, 1 piece	0.99	0.73	0.36	0.3
9682	AR292	S1W1	0-10	I/II	0-10	NW	-	2	Aluminum fragment	1.67	1.79	0.28	0.5
9682	*AR293	N1W2	5-10	II/III	5-10	NW	-	2	Basaltic glass, 1 piece	0.97	0.77	0.36	0.3
9682	*AR294	S1W1	10-20	II	10-20	NE	-	2	Basaltic glass, 1 piece	1.01	0.64	0.31	0.3
9682	AR295	S1W1	10-20	II	10-20	NE	-	2	Cut bone	2.37	0.55	0.27	0.2
9682	*AR296	S1W1	20-30	II	20-30	NE	-	2	Basaltic glass, 1 piece	0.74	0.58	0.55	0.2
9682	AR297	S1W1	20-30	II	20-30	NE	-	2	Shell fishhook fragment, bend	1.54	1.01	0.32	0.3
9682	AR298	S1W1	20-30	II	20-30	NE	-	2	Coral file fragment	2.13	1.04	1.25	1.2
9682	AR299	S2E1	5-10	II	5-10	NE	-	2	Coral file fragment	4.02	1.81	1.63	6.5
9682	AR300	S2E1	10-15	II/III	10-15	SW	-	2	Coral file fragment	3.59	1.67	1.13	4.5
9682	AR301	S2W1	0-10	II	0-10	NE	-	2	Sandstone flake	7.01	4.90	1.54	45.8
9682	AR302	S2W1	10-15	II	10-15	NE	-	2	Coral file tip	2.07	1.22	0.81	1.0
9682	AR303	S2W1	0-10	II	0-10	SE	-	2	Drill-bit fragment, shell columnella	2.79	-	0.41	0.7
9682	AR304	S4E1	5-10	II	5-10	NW	-	2	Cowrie shell bead, 2 ends perforated	2.35	1.61	1.21	3.4
9682	AR305	S4E1	5-10	II	5-10	NW	-	3	Nerita shell bead?	1.33	0.95	0.66	0.3
9682	*AR306	S2W1	10-15	II	10-15	All	-	3	Basaltic glass, 2 pieces	1.01- 1.04	0.79- 1.04	0.33- 0.33	0.4
9682	AR307	S4E1	5-10	II	5-10	N½	-	3	Basaltic glass, 1 piece	1.36	-.51	0.50	0.4
9682	AR308	S3E1	10-15	II	10-15	NE	-	2	Basaltic glass, 1 piece	0.99	1.15	0.86	1.2
9682	*AR309	S1E1	5-10	I	5-10	All	-	3	Basaltic glass, 2 pieces	1.19- 1.66	0.69- 1.10	0.27- 0.54	1.8
9682	AR310	N1E1	10-20	II	10-20	All	-	3	Basaltic glass, 1 piece	0.95	1.00	0.56	0.6
9682	AR311	S1E1	10-15	II	10-15	NE	-	2	Basaltic glass, 1 piece	1.13	0.46	0.30	0.2
9682	AR312	S1E1	5-10	II	5-10	NW	-	2	Basaltic glass, 3 pieces	1.36- 1.06	0.71- 0.89	0.17- 0.49	1.0
9682	*AR313	N1W1	20-25	II/III	20-25	SE	-	2	Basaltic glass, 2 pieces	0.92- 1.31	0.75- 0.93	0.23- 0.59	1.0
9682	AR314	S1E1	10-15	II	14	SE/R57U32	-	1	Coral file	3.01	1.43	0.84	2.3
9682	*AR315	N1W2	5-10	II/III	5-10	NW	-	2	Basaltic glass, 1 piece	1.51	1.13	0.33	0.8
9682	AR316	N1W2	0-5	I/II	0-5	NE	-	2	Cut bone	3.25	1.60	0.53	1.2
9682	AR317	S2W1	10-15	II	10-15	All	-	3	Basaltic glass, 1 piece	1.14	0.90	0.18	0.2
9682	AR318	S1W1	10-20	II	10-20	All	-	3	Basaltic glass, 2 pieces	1.11- 1.08	0.71- 0.93	0.45- 0.38	1.0

Site	Accession Number	Trench	Level (cm.)	Stratum	Depth Below Surface (cm)	Grid Location	Feature Association	Code	Description	Lgth. (cm.)	Width (cm.)	Thick (cm.)	Weight (gm.)
9682	AR319	S1E1	10-15	II	10-15	All	-	3	Cut bone	7.26	1.60	0.46	3.4
9682	AR320	S1W1	10-20	II	13	NW/R19U52	-	1	Coral abrader	8.19	4.89	2.44	69.0
9682	AR321	S1E1	0-5	I	0-5	NW	-	2	Coral abrader	8.01	6.43	2.80	94.7
2723	AR322	N2W3	20-30	II	22	NE/R75U70	-	1	Coral abrader	4.74	4.05	1.63	25.1
2723	AR323	S1W1	10-20	II	10-20	NE	-	2	Coral file fragment	1.80	1.41	1.05	1.4
2723	AR324	S1W3	0-5	I	0-5	NW	-	2	Shell fishhook point, fragment	1.46	0.42	0.36	0.1
2723	AR325	N2W1	0-10	I	7	NE/R96U73	-	1	Pearl shell fishhook	1.63	1.09	0.22	0.2
2723	AR326	N2W1	0-10	I	0-10	NE	-	2	Crumbled tin foil	4.52	2.00	1.76	1.6
2763	AR327	N1W1	0-10	II	9	SE/R75U40	-	1	Sandstone grinding stone	33.0	25.0	6.00	4.6 kilo.
2730	AR328	S1W2	10-20	II	10-20	SW	-	2	Pearl shell fishhook blank	2.88	2.69	0.51	5.2
2730	AR329	S1W2	0-15	I/II	0-15	NW	-	2	Coral file fragment	3.91	1.39	1.01	4.3
2730	AR330	S1W2	0-15	I/II	0-15	NW	-	2	Coral file tip fragment	1.61	0.82	0.63	0.6
2730	AR331	S1W2	0-15	I/II	0-15	NW	-	2	Pearl shell fishhook fragment	1.85	0.31	0.13	0.1
2730	AR332	S1W1	0-10	I/II	0-10	All	-	3	Cut bone	2.51	1.15	0.80	1.8
2763	AR333	N1W1	5-10	I/II	5-10	SE	-	2	Coral saw fragment	2.06	1.08	0.66	0.9
2763	AR334	N2W1	0-5	I/II	0-5	SE	-	2	Coral file fragment	3.61	1.30	0.83	2.9
2763	AR335	S1W1	0-3	I	0-3	SE	-	2	Cut bird bone	1.78	0.57	0.39	0.4
2763	AR336	N1E1	surface	I	surface	NW	-	2	Coral saw	6.00	2.03	1.28	12.5
2763	AR337	S1E1	0-5	I/II	0-5	All	-	3	Coral saw fragment	6.69	3.63	1.55	29.4
2731	AR338	N1W1	5-10	II	5-10	All	-	3	Hematite flake	1.34	1.16	0.53	0.9
2786	AR339	loc. on map	surface	I	surface	loc. on map	-	4	Coral abrader	10.79	9.87	5.02	456.0
2786	AR340	S1W1	0-20	I/II	20	NW/R20U54	-	4	Sandstone abrader	7.48	6.54	3.16	111.0
2786	AR341	S1W1	0-20	I/II	20	NW/R20U54+	-	4	Sandstone 'ulu maika fragment	-	5.00	3.16	80.7
2787	AR342	N1W1	0-20	I/II (rubble under wall)	0-5	All-N½	-	3	Cut bone	2.80	1.58	0.94	2.3
2787	AR343	N1W1	20-40	II	20-40	All	-	3	Cut bone	2.34	1.19	0.44	0.9
2787	AR344	N1W1	20-40	II	20-40	All	-	3	Bone fishhook fragment	1.57	0.47	0.30	0.2
2787	AR345	N1W1	20-40	II	30	SW	-	2	Coral file fragment	2.79	0.97	0.71	1.2
2787	AR346	N1W2	0-5	I	0-5	NW	-	2	Coral hammerstone	8.22	4.96	2.41	73.5
2787	AR347	N1W2	0-5	I	0-5	SW	-	2	Limestone saw or awl	11.04	5.47	1.69	117.4
2787	AR348	N1W2	5-25	II Hearth	5-25	SE	-	2	Cut bone	1.68	1.29	0.30	0.4
2787	AR349	N1W2	25-40	II	25-40	SE	-	2	Cut bone	2.31	0.63	0.20	0.4
2787	AR350	N1W2	25-40	II	25-40	SW	-	2	Cut bone	1.43	0.76	0.40	0.3
2787	AR351	N1W2	25-40	II	25-40	SW	-	2	Cut bone	1.75	0.49	0.37	0.4
2787	AR352	S3W2	surface	I	surface	NW	-	2	Coral abrader	4.40	3.66	2.41	32.2
2787	AR353	S3W1	20-40	II	20-40	NE	-	2	Worked bone	1.90	0.60	0.32	0.2
2787	AR354	S3W1	20-40	II	20-40	All	-	3	Cut bone	1.16	0.90	0.42	0.7
2787	AR355	S3W1	20-40	II	20-40	All	-	3	Pearl shell blank	1.74	1.39	0.20	0.6
2787	AR356	S3W1	40-60	III	40-60	All	-	3	Coral file	2.74	1.54	1.06	3.1
2789	AR357	S1E2	in wall	—	—	loc. on map	-	4	Basalt pebble	7.54	5.41	4.12	232.7
2789	AR358	S1W1	7-16	II	7-16	All	-	3	Coral file	3.44	1.51	0.74	2.8
2789	AR359	S1W1	7-16	II	7-16	All	-	3	Possible shell scraper	5.20	2.74	0.18	5.3
2789	AR360	S1W1	7	II	7	NW	-	2	Coral file tip	2.11	0.85	0.51	0.8
2789	AR361	N1W2	4-16	II	4-16	All	-	3	Cut bone	1.59	1.84	1.36	2.6
2789	*AR362	S1W3	8	II	8	NE	-	2	Basaltic glass, 1 piece	1.31	0.99	0.60	1.0
2789	AR363	S1W2	18	II	18	All	-	3	Cut bone	1.06	0.64	0.23	0.2
2789	AR364	S1W2	16	II	16	NE	-	2	Coral file	4.80	2.30	1.22	9.9
2790	AR365	-	surface	I	surface	loc. on map	-	4	Shot gun shell casing, brass	6.65	2.53	1.61	25.4
2787	AR366	S1E1	18-22	III	18-22	All	-	3	Fishhook blank, bone	1.45	1.00	0.23	0.3
2787	AR367	S4W1	20-25	II	20-25	SW	-	2	Coral file fragment	2.61	0.79	0.67	1.3
2787	AR368	S2W1	0-5	I/II	0-5	All	-	3	Sandstone flakes, 4 pieces	3.66-7.11	1.44-4.85	0.80-1.76	102.0

Site	Accession Number	Trench	Level (cm.)	Stratum	Depth Below Surface (cm)	Grid Location	Feature Association	Code	Description	Lgth. (cm.)	Width (cm.)	Thick (cm.)	Weight (gm.)
2787	AR369	S2W1	0-5	I/II	0-5	All	-	3	Basalt flake, 1 piece	1.77	1.06	0.51	1.7
2787	AR370	S2W1	5-10	I/II	5-10	NE	-	2	Sandstone flake, 1 piece	3.10	1.75	0.53	2.3
2787	AR371	S2W1	5-10	I/II	5-10	NE	-	2	Basalt flakes, 2 pieces	1.82- 3.00	0.89- 1.40	0.50- 0.37	3.1
2787	AR372	S2W1	5-10	I/II	5-10	NE	-	2	Coral file tip	1.69	0.63	0.46	0.5
2787	AR373	S2W1	10-30	I/II	10-30	S½	-	3	Sandstone flake, 1 piece	4.36	2.41	1.03	14.8
2787	AR374	S2W1	20-30	II	20-30	SW	-	2	Sandstone flake, 1 piece	2.97	2.56	1.18	9.1
2787	AR375	S2W1	20-30	II	20-30	SW	-	2	Basalt flake, 1 piece	3.08	1.16	0.63	4.6
2787	AR376	S2W1	30-40	II/III	30-40	SW	-	2	Cut bone	1.04	0.54	0.25	0.2
2787	AR377	S2W1	0-5	I/II	4	NE/R100U60	-	1	Coral file, tip broken	2.90	1.30	0.81	2.6
2787	AR378	S2W1	5-10	II surface	6-10	NE/R60U92	-	1	Sandstone core	9.60	9.45	4.61	469.6
2789	AR379	N1W1	10-20	II	12	NW	-	2	Coral file fragment	2.11	1.09	0.93	1.3
2789	AR380	S1W3	7-12	II	7-12	SE	-	2	Basalt cobble	10.89	7.63	5.11	542.2
2790	AR381	S2E1	0-10	II	5-10	NE	-	2	1 Piece Bone Fishhook fragment, no head	2.01	1.15	0.25	0.4
2790	AR382	S1E1	0-10	I	0-10	SE	-	2	Coral file fragment	1.95	1.69	1.16	2.9
2790	AR383	S1E1	0-10	I	0-10	SE	-	2	Puka shell bead	1.16	-	0.49	0.6
2790	AR384	S2E1	0-10	II	5-10	SE	-	2	Basalt flake drill-bit	3.94	2.09	0.97	8.2
2790	AR385	S2E1	0-10	I	0-5	NE	-	2	Coral file fragment	1.61	1.64	1.01	2.1
2790	AR386	S2E1	0-10	I	0-10	NW	-	2	Cut bone	2.01	1.35	0.34	0.7
2790	AR387	S2E1	0-10	I	0-10	NW	-	2	Puka shell bead	0.90	-	0.27	0.2
2790	AR388	S2E1	10-20	II	10-20	SW	-	2	Coral file tip	1.66	0.68	0.49	0.6
2790	AR389	S1W2	10-20	I/II	10-20	All	-	3	Basalt flakes, 2 pieces	0.99- 2.02	1.17- 1.02	0.20- 0.20	1.1
2790	AR390	S1W2	10-20	II	10-20	SW	-	2	Cut bone	2.02	0.30	0.10	0.1
2790	AR391	T.T.	10-20	II	10-20	E½	-	3	Cut shell	0.71	0.48	0.20	0.5
2790	AR392	S2W1	20-30	II	20-30	SE	-	2	Basalt flake, 1 piece	1.21	0.74	0.15	0.1
2790	AR393	S1W2	20-30	II/III	20-30	All	-	3	Coral file fragment	2.24	1.79	1.56	4.0
2790	AR394	S1W2	20-30	II/III	20-30	All	-	3	Coral file fragment	3.05	1.50	0.68	2.7
9669	AR395	TR1	0-5	I	0-5	All	-	3	Limestone flakes, 4 pieces	2.49- 4.22	1.65- 1.76	0.80- 0.75	15.5
9682	AR396	N1W1	10-20	II	10-20	All	-	3	Coral file fragment	1.50	2.26	1.65	3.1
9682	AR397	S1W1	0-10	I/II	0-10	All	-	3	Coral file fragment	1.95	1.40	0.86	1.3
9682	AR398	S1W1	0-10	I/II	0-10	All	-	3	Coral abrader fragment	3.24	3.31	3.11	24.7
9682	AR399	S1W1	0-10	I/II	0-10	All	-	3	Coral saw? fragment	3.80	2.14	1.60	7.6
9682	AR400	S1W2	0-10	I/II	0-10	All	-	3	Coral file tip	1.34	0.89	0.43	0.5
9682	AR401	N1E1	10-20	II	10-20	All	-	3	Coral abrader fragment	6.26	3.91	3.29	48.0
2722	AR402	TT1	0-10	I	0-10	SW	-	2	Limestone flakes, 2 pieces	2.64 7.38	2.52 4.68	0.40 1.86	42.5
2712	AR403	N4E1	0-7	I	0-7	All	-	3	Sandstone flake, 1 piece	5.19	5.17	2.11	68.0
2712	AR404	N2E1	0-10	II	0-10	All	-	3	Basalt flake, 1 piece	8.16	5.92	1.16	60.0
2712	AR405	N4E1	0-20	II	0-20	All	-	3	Sandstone flakes, 3 pieces	3.01- 5.71	2.21- 4.80	0.58- 0.87	42.5
2731	AR406	N1E2	15-20	II	15-20	W½	-	3	Limestone flakes, 2 pieces	3.16- 3.91	2.21- 2.45	0.71- 1.12	13.8
2731	AR407	N1E1	0-5	I	0-5	All	-	3	Limestone flake, 1 piece	8.29	4.90	1.99	63.2
2731	AR408	N1E1	15-25	II	15-25	All	-	3	Sandstone flakes, 3 pieces	2.06- 5.09	1.50- 2.90	0.62- 0.56	14.0
2731	AR409	N1E1	5-10	II	5-10	All	-	3	Limestone flakes, 4 pieces	2.51 4.58	1.49 2.60	0.74 1.52	39.4
2712	AR410	N2W3	0-10	I	0-10	All	-	3	Basalt and limestone flakes, 9 pieces	1.50- 4.11	1.31- 2.55	0.42- 1.22	78.7
2712	AR411	N2W3	0-10	I	0-10	All	-	3	Limestone flakes, 5 pieces	1.79- 2.99	0.84- 2.71	0.36- 0.69	15.6
2712	AR412	N2W1	0-10	II	5-10	All	-	3	Basalt flakes, 1 piece; limestone flake, 1 piece	2.05- 2.00	1.24- 1.79	0.52- 0.41	3.3

Site	Accession Number	Trench	Level (cm.)	Stratum	Depth Below Surface (cm)	Grid Location	Feature Association	Code	Description	Lgth. (cm.)	Width (cm.)	Thick (cm.)	Weight (gm.)
2712	AR413	N2W1	10-20	II	10-20	All	-	3	Limestone flakes, 3 pieces	1.94 3.37	1.78 2.19	0.46 0.86	10.1
2790	AR414	S1W2	20-30	II/III	20-30	All	-	3	Limestone flakes, 3 pieces	2.30- 3.21	1.62- 2.59	0.67- 1.50	16.1
2791	AR415	-	surface	I	surface	loc. on map	-	1	Railroad spike, steel	8.39	1.29	1.06	105.2
2791	AR416	-	surface	I	surface	loc. on map	-	1	Bell-shaped metal object-railroad purposes	10.70	7.21	-	132.1
2789	AR417	S1W3	0-10	II	8	N½	-	3	Limestone flakes, 2 pieces	1.29- 1.79	0.80- 1.44	0.49- 0.31	1.2
2789	AR418	N1W2	4-16	II	4-16	All	-	3	Basalt flakes, 2 pieces	0.89- 2.43	0.72- 1.33	0.17- 0.40	1.9
2790	AR419	S2E1	0-10	I/II	0-10	All	-	3	Sandstone flake, 1 piece	7.93	4.66	1.91	75.4
2790	AR420	S2E1	0-10	I/II	0-10	All	-	3	Limestone pebble, utilized?	2.34	2.34	1.40	4.9
2790	AR421	S1E1	0-10	I	0-10	All	-	3	Limestone flake, 1 piece	3.29	2.61	1.25	9.0
2790	AR422	S2W1	0-10	I	0-10	E½	-	3	Limestone flake, 1 piece	3.25	2.21	1.14	8.4
2790	AR423	S1E1	10-20	II	10-20	All	-	3	Basalt flakes, 2 pieces	1.84- 2.11	0.99- 0.84	0.60- 0.75	3.0
2787	AR424	S3W2	0-10	I	0-10	All	-	3	Basalt flakes, 2 pieces	2.20 1.67	1.71 2.20	0.86 1.34	10.5
2787	AR425	N1W2	5-25	II	5-25	All	-	3	Worked shell	2.90	1.60	0.31	1.7
2787	AR426	S1W1	15-20	II	15-20	All	-	3	Cut bone	1.70	0.55	0.30	0.2
2787	AR427	N1W1	0-20	I	0-5	All	-	3	Basalt flake, 1 piece	2.30	1.54	0.50	2.4
2787	AR428	S4W2	20-40	II	20-40	All	-	3	Basalt flakes, 2 pieces	1.20- 3.50	0.81- 1.59	0.61- 0.45	4.8
2787	AR429	S4W2	20-40	II	20-40	All	-	3	Bone fishhook composite point fragment, repaired with #431	1.31	0.40	0.22	0.1
2787	AR430	S4W2	40-60	II	40-60	All	-	3	Bone fishhook blank	1.57	1.06	0.49	2.7
2787	AR431	S4W2	40-60	II	40-60	All	-	3	Bone fishhook composite base	1.56	0.70	0.31	1.4
2787	*AR432	S4W2	40-60	II	40-60	All	-	3	Basaltic glass, 1 piece	1.[illegible]4	1.13	0.25	2.4
2787	AR433	N1W2	40-60	II	40-54	All	-	3	Ground basalt flake with striations	2.51	2.74	0.58	5.1
2787	AR434	S4W2	40-60	II	40-60	All	-	3	Coral file tip	1.36	0.73	0.43	0.2
2787	AR435	S4W2	40-60	II	40-60	All	-	3	Puka shell bead	1.01	-	0.40	0.3
2787	AR436	S4W2	40-60	II	40-60	All	-	3	Coral file fragment	2.34	1.54	1.00	2.7
2787	AR437	S4W2	40-60	II	40-60	All	-	3	Coral file fragment	1.74	1.49	1.31	2.5
2791	AR438	-	surface	I	surface	loc. on map	-	4	Railroad spike metal	9.41	1.03	1.00	67.0
2712	AR439	N1E1	0-10	I	3 cm bs	NE/R62U80	-	1	Coral abrader	9.00	4.40	2.49	59.2
2712	AR440	N2W1	0-10	II	5-10	All	-	3	Cut bone	1.41	0.97	0.60	0.6
2712	AR441	N1W1	0-10	I	0-5	NW	-	2	Coral file	2.50	1.20	1.00	2.3
2712	AR442	N1W1	0-10	I	0-5	NW	-	2	Coral file	2.36	1.26	0.81	1.5
2712	AR443	N1W1	0-10	I	0-5	NW	-	2	Cut bone	1.44	0.55	0.14	0.1
2712	AR444	N1W1	0-10	I	0-5	NW	-	2	Basalt flake, 1 piece	1.03	0.90	0.44	0.5
2712	AR445	N1W1	5-10	II	5-10	NE	-	2	Cut bone, broken fishhook blank	2.45	2.29	0.24	1.9
2712	AR446	N1W1	5-10	II	5-10	NE	-	2	Cut bone	2.26	0.66	0.30	0.4
2712	AR447	N1W1	5-10	II	5-10	NE	-	2	Cut bone	1.44	0.69	0.30	0.4
2712	AR448	N1W1	5-10	II	6	NE/R75U100	-	1	Coral file	3.87	1.69	1.51	5.5
2712	AR449	N2W1	10-20	II	10-20	All	-	3	Coral file fragment	2.13	1.18	0.76	1.6
2712	AR450	N2W1	0-10	II	3-10	SW/R40U40	-	1	Coral file fragment	2.50	0.96	0.82	1.3
2712	AR451	N2W1	0-10	II	0-5	NE	-	2	Coral file fragment	1.71	1.14	0.81	0.6
2712	AR452	N3W1	0-10	II	5-10	All	-	3	Coral file fragment	1.79	1.25	0.42	1.0
2712	AR453	N3W1	0-10	II	5-10	-	-	-	Coral file fragment	1.90	1.15	0.91	1.5
2712	AR454	N2W2	10-20	II	10-20	N½	-	3	Bone fishhook bend	1.21	0.25	0.44	0.3
2712	AR455	N3W3	0-10	II	5-10	All	-	3	Fish bone pick?	3.96	0.31	0.16	0.3
2712	AR456	N3E1	0-10	II	5-10	NE	-	2	Basalt flake	1.69	1.11	0.46	1.1
2712	AR457	N3E3	0-10	I	0-10	All	-	3	Rusty metal fragment	2.22	1.09	0.17	0.5

Site	Accession Number	Trench	Level (cm.)	Stratum	Depth Below Surface (cm)	Grid Location	Feature Association	Code	Description	Lgth. (cm.)	Width (cm.)	Thick (cm.)	Weight (gm.)
2712	AR458	in wall	+35	--	--	loc. on map	-	1	Basalt core	5.54	5.24	2.73	96.0
2712	AR459	N2W3	0-10	I	0-5	All	-	3	Basalt flake	5.92	5.60	1.84	78.4
2712	AR460	-	5-10	II	5-10	NW	-	2	Bone fishhook point, unfinished	3.54	1.12	0.50	1.1
2712	AR461	-	surface	I	surface	loc. on map	-	1	Live .50 caliber shell, metal	13.74	-	2.00	110.0
2712	AR462	-	surface	I	surface	loc on map	-	1	Basalt flake	6.61	3.80	2.41	63.5
2712	AR463	-	surface	I	surface	loc. on map	-	1	Bullet shell casing, .30 caliber, brass	6.29	-	1.19	2.8
2712	AR464	-	surface	I	surface	loc. on map	-	1	Bullet shell casing, .30 caliber, brass	6.29	-	1.19	2.8
2712	AR465	-	surface	I	surface	loc. on map	-	1	Bullet shell casing, .30 caliber, brass	6.29	-	1.19	2.8
2712	AR466	-	surface	I	surface	loc. on map	-	1	Bullet shell casing, .30 caliber, brass	6.29	-	1.19	2.8
2712	AR467	-	surface	I	surface	loc. on map	-	1	Bullet shell casing, .30 caliber, brass	6.29	-	1.19	2.8
2712	AR468	-	in cobble fill in north wall			loc. on map	-	1	Bullet shell casing, .30 caliber, brass	6.29	-	1.19	2.8
2712	AR469	-	surface	I	surface	loc. on map	-	1	Bullet shell casing, .30 caliber, brass	6.29	-	1.19	2.8
2712	AR470	in wall	-	-	-	loc. on map	-	1	Coral file fragment	2.36	2.31	1.71	6.9
2712	AR471	-	-	-	-	loc. on map	-	1	Modified basalt pebble, ground	2.31	1.90	1.50	12.0
2712	AR472	in wall	-	-	-	loc. on map	-	1	Coral file	2.74	1.65	1.40	5.0
2712	AR473	in wall	+0-5	I	+0-5	loc. on map	-	1	Coral file fragment	2.04	1.40	1.50	3.3
2712	AR474	in wall	-	-	-	loc. on map	-	2	Coral abrader	5.30	5.21	4.83	98.0
2712	AR475	in wall	-	surface	-	loc. on map	-	1	Basalt hammerstone, possible imu stone	9.63	6.00	3.49	268.5
2780	AR476	TT3A	0-10	I	0-5	SE	-	2	*Metal fragments, 3 pieces*	1.70	0.55	0.22	0.8
2712	AR477	in wall	-	-	-	loc. on map	-	1	Brass shell casing, .30 caliber	6.29	-	1.19	2.8
2746	AR478	TT2	0-5	I	4	NW/R40U95	-	1	Metal pipe fitting	0.9	2.10	-	21.6
2730	AR479	TT1	0-10	I	0-10	SW	-	2	Limestone flake	2.69	1.24	0.95	2.8
2712	AR480	TT1A	30-40	I	30-40	All	-	3	Basalt flake, 1 piece	1.37	0.74	0.30	0.2
2712	AR481	N1W1	0-10	II	5-10	All	-	3	Basalt flake, 2 pieces	1.93	0.92	0.41	1.6
9669	AR482	T.T.	surface	I	surface	All	-	3	Bone awl or pick	5.01	0.82	0.37	1.1

APPENDIX V

TABLE 18

MASTER ACCESSION OF ARCHAEOLOGICAL AND PALEONTOLOGICAL SITES

Permanent Site No.	Temporary Field No. (Davis 1978)	Bishop Museum No. (Sinoto 1976)	Site Type	Tested x-1980 BM-1976	Excavated 1980
Study Area Ia					
2712	2700-1a		enclosure	x	x
2712	2700-1b		platform	x	
2714	2700-2		enclosure	x	
2715	2700-3		L-shape	x	
2716	2700-4		enclosure	x	
2717	2700-5		ahu	x	
2718	2700-6		mound		
2719	2700-7		mound	x	
2720	2700-8		ahu		
2721	2700-9		modified sink	x	
2722	2700-10		wall		
2723	2701-1		L-shape	x	x
2724	2701-2		ahu		
2725	2701-3		modified sink	x	
2726	2701-4		modified sink		
2727	2701-5		platform	x	

* - Not relocated during this study (1980).

\+ - Paleontological site.

** - Specific Feature noted by Davis (1978) was not found. Complex of sinks at the map location of Davis' Sites 2711-8 and 2711-25 were inspected by Dr. Storrs Olson.

Appendix V, Table 18 Continued
Master Accession List of Archaeological and Paleontological Sites

Permanent Site No.	Temporary Field No. (Davis 1978)	Bishop Museum No. (Sinoto 1976)	Site Type	Tested x-1980 BM-1976	Excavated 1980
2728	2701-6		ahu	x	
2729	2701-7		modified sink		
2730	2702-1		enclosure	x	x
2731	2702-2		enclosure	x	x
2732	2702-3		enclosure	x	x
2733	2702-4		C-shape	x	
2734	2702-5		ahu		
2735*	2702-6		modified sink		
2736*	2704-1		C-shape		
2737*	2704-2		modified sink		
2738*	2704-3		modified sink		
2739*	2704-4		modified sink		
2740*	2704-5a		modified sink		
2741*	2704-5b		modified sink		
2742*	2704-6		modified sink		
2743*	2704-7		modified sink		
2744*	2704-8		wall		
2745	2705-1		L-shape	x	x
2746	2705-2		C-shape	x	
2747	2705-3a		ahu		
2748	2705-3b		ahu		
2749	2705-4		ahu		

Appendix V, Table 18 Continued
Master Accession List of Archaeological and Paleontological Sites

Permanent Site No.	Temporary Field No. (Davis 1978)	Bishop Museum No. (Sinoto 1976)	Site Type	Tested x-1980 BM-1976	Excavated 1980
2750	2705-5		ahu		
2751	2705-6a		ahu		
2752	2705-6b		ahu		
2753	2705-7		modified sink		
2754	2705-8		modified sink		
2755	2705-9		modified sink		
2756	2705-10		modified sink		
2757	2705-11		modified sink		
2758	2705-12		modified sink		
2759	2705-13		wall		
2622	2706-21		modified sink	x+	
2760	2760-23		modified sink		
2761	2706-25		clearing		
2762	2706-22a		modified sink	x+	
2763	2706-22b		sinkhole	x	x

Study Area Ib

9646		B6-149	C-shape	x	
9647		B6-150	C-shape	x	
9648		B6-151	modified sink	x	

Appendix V, Table 18 Continued
Master Accession List of Archaeological and Paleontological Sites

Permanent Site No.	Temporary Field No. (Davis 1978)	Bishop Museum No. (Sinoto 1976)	Site Type	Tested x-1980 BM-1976	Excavated 1980
9649		B6-152	natural feature	x	
9650		B6-153	remanant wall		
9651		B6-154	modified sink		
9652*		B6-155	remnant wall		
9653		B6-156	pavement		
9654		B6-157	natural feature	x	
9655		B6-158	modified sink		
9656		B6-159	natural feature	x	
9657		B6-160	remnant wall		
9658		B6-161	modified sink		
9659		B6-162	sinkhole	x	
9660		B6-163	modified sink		
9661		B6-164	enclosure	x	
9662*		B6-165	ahu with sink		
9663		B6-166	wall remnant		
9664		B6-167	large complex	x	
9665		B6-168	platform	x	
9666		B6-169	ahu		
9667		B6-170	paved area		

Appendix V, Table 18 Continued
Master Accession List of Archaeological and Paleontological Sites

Permanent Site No.	Temporary Field No. (Davis 1978)	Bishop Museum No. (Sinoto 1976)	Site Type	Tested x-1980 BM-1976	Excavated 1980
9668		B6-171	natural geological feature		
9669		B6-172	habitation sink	x	x
9670		B6-173	sinkhole	x	
9671		B6-174	ahu		
9672		B6-175	ahu		
9673		B6-176	ahu		
9674		B6-177	ahu		
9675		B6-178	platform		
9676		B6-179	platform	x	
9677*		B6-180	C-shape		
9678		B6-181	ahu		
9679		B6-182	C-shape	x	
9680		B6-183	C-shape		
9681		B6-184	remnant wall		
9682		B6-185	enclosure	x	x
9683		B6-186	U-shape	x	
9684		B6-187	modified sink	x	
9685		B6-188	natural depression		
Optional Area I					
2764	2707-1		path		
2765	2707-2		enclosure	x	
2766	2707-3	B6-66	enclosure	x	
2767	2707-4	B6-98	ahu		BM

Appendix V, Table 18 Continued
Master Accession List of Archaeological and Paleontological Sites

Permanent Site No.	Temporary Field No. (Davis 1978)	Bishop Museum No. (Sinoto 1976)	Site Type	Tested x-1980 BM-1976	Excavated 1980
2768	2708-1	B6-71	enclosure	BM	x
2769	2708-2f	B6-72	ahu	x	
2770	2708-2g	B6-72	ahu	x	
2771	2708-3a	B6-68	ahu	x	
2772	2708-3b	B6-68	ahu	x	
2773	2708-4		ahu		
2774	2708-5		ahu	x	
2775	2708-6	B6-68	walled depression		
2776	2708-7		modified sink	x	
2777	2709-1	B6-77	enclosure	BM	x
2778	2709-2a	B6-69	C-shape	BM	x
2779	2709-2b	B6-69	C-shape	x	
2780	2709-3a	B6-74	C-shape	x	x
2781	2709-3b	B6-74	C-shape	x	x
2782*	2709-4	B6-87	C-shape		
2783	2709-5	B6-87	ahu	x	
2784	2709-6	B6-75	modified sink	BM	x
2785	2709-7	B6-73	modified wet sink	x	
2786	2710-1	B6-63	enclosure	BM	x
2787	2710-2	B6-62	enclosure	BM	x
2788	2710-3	B6-89	enclosure(?)	x	
2789	2710-4	B6-88	enclosure	x	x
2790	2710-5	B6-99	sinkhole	BM	x
2791	2710-6a	B6-88	rollway bed	x	
2792	2710-6b		wall		
2793*	2710-7		ahu		

Appendix V, Table 18 Continued
Master Accession List of Archaeological and Paleontological Sites

Permanent Site No.	Temporary Field No. (Davis 1978)	Bishop Museum No. (Sinoto 1976)	Site Type	Tested x-1980 BM-1976	Excavated 1980
2794	2710-8		ahu	x	
2795	2710-9		ahu		
2796	2710-10		modified sink	x	
2797	2710-11		ahu		x
2798	2710-12		natural sink	x	
2799*	2710-13		modified sink		
2603*	2710-14		midden sink	x	
2604	2711-1	B6-60	enclosure	x	x
2605*	2711-4		ahu		
2606	2711-5a		ahu	x	
2607	2711-5b		ahu	x	
2608	2711-7		ahu	x	
2609**	2711-8		burial sinkhole	x	
2610	2711-9a		natural sinkhole		
2611	2711-9b		natural sinkhole		
2612	2711-9c		natural sinkhole		
2613	2711-13	B6-59	natural sinkhole		
2614	2711-18	B6-86	modified sink	x	
2615	2711-19		natural sinkhole		

Appendix V, Table 18 Continued
Master Accession List of Archaeological and Paleontological Sites

Permanent Site No.	Temporary Field No. (Davis 1978)	Bishop Museum No. (Sinoto 1976)	Site Type	Tested x-1980 BM-1976	Excavated 1980
2616	2711-20		natural sinkhole	x	
2617	2711-22	B6-61	habitation terrace		x
2618	2711-23		clearing		
2619**	2711-25		sinkhole		
2620	2711-26		burial sinkhole		x
2621	2711-27		burial sinkhole		x
2623+	9661-P1				x
2624+	9670-P1				x
2625	2710-S1			x	
2626	2710-S2			x	
2627	2710-S3			x	

GLOSSARY

A Horizon	A mineral soil horizon composed of organic matter accumulation forming at or near the surface.
abrupt	A characteristic of stratigraphic boundaries.
abut	Describes the manner of contact between two walls constructed as independent units. (See interlock below.)
adventive	Not native; an exotic that is introduced, often accidentally and imperfectly naturallized.
ahu	*Mount or heap (of rocks).*
ahupua'a	Traditional Hawaiian land division, largest land unit within a district (moku), extending from the interior mountains or uplands to the outer reef, where there is a reef or about one-half (½) to one (1) mile at sea where there is no reef. Were self sufficient economic units.
alluvial	A mode of sediment deposition, i.e., deposited by streams.
alluvium	Sedimentary material deposited by streams.
B Horizon	A mineral horizon dominated by weathering and pedogenic clay.
basaltic glass	Supercooled lava having uniform texture and non-crystaline composition.
Bir Horizon	A B horizon dominated by illuvial iron.
bioturbation	Mixing of sediments by living organisms.
C Horizon	A subsurface horizon of relatively unaltered parent material which can be modified by weathering or salt accumulation.
coetaneous	Of the same age; contemporary.
colluvial	A mode of sediment deposition, i.e, deposited by gravity fall, slope wash, or mud flow.
colluvium	Sedimentary material deposited by gravity fall; slope was mud flow.

column sample	Sediments collected systematically down a stratigraphic profile at specified intervals.
core fill	A style of rock wall construction using two parallel rock alignments to form the wall faces, and loosely stacked rocks between the faces to form the bulk of the wall.
crenulate sutures	Scalloped furrows.
estivating	To spend the summer, usually at one place and sometimes in relative inactivity.
facing	Denotes the sides of stone walls.
feature	A discreet component of an archaeological site such as a fireplace, posthole, etc.
hale moe	Sleeping house; one of the structures comprising kauhale.
'ili'ili	A pebble-sized, waterworn stone; also 'ili.
illuvial	Translocated into.
interlock	The manner of contact between two walls constructed as dependent units.
kahakai	Beach, seashore. One of three major verticle terrestrial zones distinguished in the traditional Hawaiian economic system
Kalaeloa	the long point (lit.); traditional Hawaiian name for Barber's Point.
Kanaloa	One of the four great gods of Hawaii and polynessia. God of the ocean. Often associated with Kane.
Kane	One of the four great gods of Hawaii and polynessia. "The leading god among the great gods" (HM 42); a god of creation and the ancestor of chiefs and commoners; a god of sunlight, freshwater, and forests (Thrum, p.82) to whom no human sacrifices were made. (Pukui and Elbert 1965:387)
karstic	A dissected land form in limestone regions.
kiawe	(Prosopis pallida) an exotic xerophytic hardwood tree native to the Americas and West Indies. Economically important in Hawai'i for animal fodder and charcoal manufacturing.

kauhale	A group of houses comprising a Hawaiian home.
makai	Toward the sea, in the direction of the ocean.
mauka	Toward the uplands, inland, in the direction of the mountains.
midden	Food remains and raw materials deposited in an archaeological site by humans.
O Horizon	Surface horizon dominated by fresh or partly decomposed organic material.
'o'ili 'uwi'uwi	A fish (Stephanolepis spilosomus; possibly S. princei also); so called because of the squealing noise it makes.
oviparous	Producing eggs that develop and hatch outside the maternal body.
ovoviviparous	Producing eggs that develop and hatch outside the maternal body.
pākanu	(Lit.) planting enclosure; garden, cultivated field.
paniolo	cowboy; probably derived from the Spanish word espanol.
prehistoric(?)	Used to denote a stratified cultural layer (and associated features) in which the tool assemblages are predominantly prehistoric in material and form but were used well into the historic period.
quantitative dating	Dating method which measures time according to a quantitative scale, e.g., basaltic glass hydration rind measurement and radio carbon measurement.
site	A discreet structure (including sinkholes) which contains evidence of constuction or modifcation.
solution sink	A cavity or hole resulting from dissolving of limestone by rainwater in a limestone environment.
spodosol	A soil order with accumulations of iron and organic matter in the B Horizon characteristic of moist woodlands.
Structural B Horizon	A B horizon characterized by soil structure.

uka	Uplands. One of the major verticle terrestrrial zones distinguished in the traditional Hawaiian economic system.
waena	Between uka and kahakai, usually cultivated field or garden plot. One of the three major verticle terrestrial zones distinguished in the traditional Hawaiian economic system.
whorl	One turn of a univalve shell.

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March
1981

To the Reader:

The following report entitled "Nonmarine Molluscs and Paleoecology At Barber's Point, O'ahu" by Patrick V. Kirch and Carl C. Christensen of the B.P. Bishop Museum is being appended to this report in its entirety as it was submitted. It is reproduced here in its entirety exactly as it was submitted as a final report to ARCH. This has been done in reponse to the wishes of the authors and is submitted without comment from the editors.

NONEMARINE MOLLUSCS AND PALEOECOLOGY AT BARBERS POINT, O'AHU

Patrick V. Kirch
and
Carl C. Christensen

Prepared for
Archaeological Research Center Hawaii, Inc.

Department of Anthropology
BERNICE P. BISHOP MUSEUM
July 1980

CONTENTS

Tables

Figures

INTRODUCTION

In 1976, the Bishop Museum conducted an archaeological survey and test excavations at Barber's Point (Sinoto 1976), revealing the rather startling presence, in limestone sink deposits of fossil bones of endemic birds, including a number of extinct species unknown to science. During a subsequent salvage phase of archaeological investigation (Sinoto 1978), one of us (PVK) became aware that these paleontological deposits contained, in addition to avian remains, an abundance of fossil and subfossil shells of terrestrial snails. A preliminary study (Kirch 1978) was made of these snails from one of the salvaged sites (OA-B6-78), from excavated soil samples (unfortunately, without the benefit of field, quantitative sampling). The results indicated some potential for the interpretation of paleo-environmental change, of obvious relevance to the question of avifaunal extinction, and further quantitative work was recommended.

In April 1980, we were requested by Dr. H. Hammatt of ARCH, Inc. to conduct further investigations of landsnails in archaeological and paleontological sites to be excavated under his direction. In cooperation with the ARCH field team, we obtained column samples from two limestone sinks containing fossil birdbone, two habitation sites, and one small, culturally sterile, sink. In addition, we sampled the deep sink (B6-78) previously excavated by Sinoto (1978). This report presents the results of our analyses for all sites except one of the two sinks (Site 2706-22B) excavated by ARCH, the samples from which will be processed at a future date.

Although terrestrial snails have been used extensively by archaeologists and paleontologists in the reconstruction of ancient environments in England and the continental United States (e.g., Evans 1972; Kerney 1966; Cheatum & Allen 1964), the technique is still embryonic in its application to Hawaiian situations. The authors have been collaborating on the analysis of landsnails from archaeological sites in Hawai'i and other Pacific Islands (e.g., Kirch 1975; Kirch and Christensen 1979; Christensen and Kirch 1980), and results to date are extremely promising. Nevertheless, we stress that we are still in the experimental stage in developing analytical and interpretive procedures (the present project being, in fact, the first such analysis to receive funding as part of a "contract archaeology" program). Therefore, we have chosen to err, as it were, on the side of caution. As a result of this project, however, we are even more firmly than ever convinced that paleo-malacological studies are a significant source of information on prehistoric Hawaiian environments, including the often-salient effects of man's actions.

MATERIAL AND METHODS

The principles underlying paleo-malacological analysis are rather simple, and parallel those of palynology. Landsnails are, firstly, ubiquitous in most ecological communities, and given proper conditions for their preservation (usually a calcareous edaphic environment), are also abundant in ancient sediments. Secondly, snails are especially sensitive to local environmental conditions, particularly vegetation and its effect upon moisture (Peake 1978). In the Hawaiian Islands, terrestrial gastropods--along with the vascular plants, insects, and birds--underwent extensive adaptive radiation, resulting in more than 1,200 endemic species (in 12 families), from perhaps 25 ancestral immigrant stocks (Zimmerman 1948). Many of these species have rather restricted ranges, and are sensitive to change in ecological conditions. Unfortunately, we cannot claim a complete understanding of the taxonomy of Hawaiian snails (many species are as yet undescribed, and revisions of major groups are necessary), let alone their ecology. These deficiencies in malacological knowledge at times hamper the effectiveness of paleo-ecological interpretations based upon landsnail evidence.

In essence, paleo-malacological analysis is based upon the assumption that the specific composition of a fossil landsnail assemblage should reflect local ecological conditions at the time of death and burial of the snails, just as pollen analysis assumes that the frequencies of pollen grains in a particular deposit reflect the vegetation from which they were derived. While valid, this underlying assumption may potentially be negated by a number of variables. These include taphonomic factors of burial and preservation of the fossil assemblage (e.g., the potential mixing of deposits by bio-turbation, etc., and the adequacy of sampling. Given careful consideration of these potential error factors, however, snail analysis can provide accurate information on past environments, and has been shown to accord closely with results obtained through pollen analysis (Evans 1972). The details of our field and laboratory procedures are outlined below, and are diagrammed in Figure 1.

Sampling. Soil samples for fossil snail extraction were taken as continuous columns (5 or 10 cm^2 in area) cut into exposed vertical stratigraphic sections. Columns were taken at a point where the stratigraphic section was relatively complete and apparently free of disturbance. Sampling intervals ranged from 2 to 10 cm in depth, but did not cross stratigraphic boundaries. At the time that samples were collected, notes were also made of the stratigraphic profile, although we did not conduct a detailed analysis, since this was to be accomplished by the ARCH team.

Extraction. In the laboratory, each sample was air-dried and weighed on an Ohaus triple-beam balance. The sample was then wet-sieved through a series of 4-mm, 1-mm, and 0.5-mm meshes (the less than 0.5-mm fraction was not retained). These fractions were oven-dried (90° F) for 24 hours, weighed, and bagged separately.

The 4-mm and 1-mm fractions were hand-sorted under a low-power (ca. 7X) microscope, and all countable snails (those including the apex) and fragments of species not represented by countable apices, as well as bones, charcoal, marine shells, etc., were removed. In the case of a single fraction (topmost of site B6-78), snails were so numerous that only a portion of the 1-mm fraction was sorted; a correction factor was introduced on the basis of sorted portion/total weight. In all other instances the entire 4-mm and 1-mm fractions were sorted for snails. Although workers in other regions routinely separate snails retained by the 0.5-mm mesh, the presence of heavy calcareous deposits on shells in some deeper levels made recognition of heavily-encrusted shells impossible; in the interest of consistency, 0.5-mm fractions were therefore not considered in this analysis.

Counting and Identification. During the project, a total of 21,270 snails were counted and identified. To prevent counting broken shells twice, only fragments containing the shell apex (and, of course, intact shells) were counted. An exception was made in the case of subfossil snail eggs; since only *Lamellaxis gracilis* of all the species present at Barber's Point is oviparous and since embryonic shells recognizable as belonging to the family Subulinidae were found in most of those eggs opened), each egg was counted as one individual of *L. gracilis*. Identifiable, non-apical fragments of species not otherwise represented in a sample are indicated in the data tables with a plus sign (+). Living snails (principally *Gastrocopta*) found in archaeological samples were ignored as resulting from contamination; this is certainly true with *Gastrocopta* in site B6-78, as these must have been sealed to the sides of the excavation, which had been left open for two years.

Given the large number of endemic Hawaiian species of terrestrial snails, it was imperative that identifications be based not only on published keys and descriptions, but on the basis of one-to-one comparisons with reference material. In this regard we were fortunate in having access to the extensive collections of the Division of Malacology, B. P. Bishop Museum. In most cases identification to the species level was possible; where the condition of the specimens (broken, immature, etc.) or the unsettled taxonomy of the group (as in the case of *Tornatellides*) prevented precise identification, determination of family or generic level was made. In a few cases, shells were so poorly preserved that no identification was possible. It should be noted that two of the species reported here are previously undescribed in the malacological literature. We intend to publish descriptions of these new species at a later date.

Statistical and Graphical Analysis. Raw counts of snails for each sample are presented in Tables 2, 4, 6-8. Since sample size varied, it is not possible to base inter-sample comparisons and interpretations on such raw scores. We have adjusted the original counts by converting them to percentage scores. Alternatively, the data could be standardized by conversion to concentration indices (e.g., snails/100 g of sediment); we have calculated such indices only for the total number of snails per sample.

In the present analysis we have not attempted to estimate statistical error or confidence intervals for the reported frequencies. For those interested in calculating confidence intervals on our data, the multinomial distribution formulae of Mosimann (1965) for pollen data are applicable.

The results of these analyses can most readily be understood visually, and graphic summaries of each stratigraphic column are presented in Figures 2, 4, 6 and 7. In interpreting the stratigraphic columns of the two deeper sinks (B6-78 and 9670-P1), we have made use of paleoecological similarity matrices. As discussed by Pielou (1979), such matrices are useful in determining the degree of grading, or of discontinuity, in a stratigraphic sequence. The similarity matrix itself is calculated using Whittaker's (1952) Proportional Similarity Index,

$$PS = \sum_{j} \min\left(\frac{x_{j1}}{T_1}, \frac{x_{j2}}{T_2}\right)$$

where T_i is the quantity of all snail species in sample i, and x_{ji} is the quantity of species j in sample i. The extent to which the matrix is graded is determined by the use of the Q/Q_{max} ratio, as described by Pielou (1979).

Ecological Interpretations. Ecological data pertinent to the various species was abstracted from published sources, when available, or from data associated with specimens in the collection of the Bishop Museum; because of time constraints, no extensive search of the latter material was possible, and conclusions should be regarded as preliminary. Because detailed data on association of particular snail species with host plant species, such as is routinely available to snail analysts in Europe and the continental U.S., is not available for Hawaiian snails, it was decided that the best way to characterize the snails was as: Native, extinct (NE), including species locally extinct but living elsewhere than in the Barber's Point study area; Native, extant (NL), still present in the study area; Introduced (I), either prehistorically or historically; and Freshwater (FW), snails that dwell in fresh or brackish water conditions.

In order to determine the nature of the modern litter fauna of the region, a sample of leaf litter from the vicinity of B6-78 was taken; all live snails (as evidenced by mucus seals, visible animal, etc.), were sorted out by hand and counted; dead shells were ignored so as not to allow contamination by subfossil shells mixed in the soil. Results are presented in Table 1. Living species not inhabiting litter are under-represented by this count. *Succinea caduca* and *Tornatellides* are certainly more common in the area than indicated by the litter sample (*Succinea* is found sealed under rocks, and *Tornatellides* may be arboreal).

Table 1

COMPOSITION OF MODERN LITTER FAUNA

Taxon	Count	Percent
Lamellidea gracilis	146	29.3
Tornatellides sp.	18	3.6
Lyropupa perlonga	16	3.2
Gastrocopta servilis	318	63.7
Succinea caduca	1	0.2

SYSTEMATIC REVIEW

The Barber's Point snails were sorted into 19 taxonomic categories (not including unidentified), probably representing between 21 and 25 species. These categories are reviewed below in systematic order, including available data on ecological range.

Family HELICINIDAE

Orobophana uberta (Gould, 1847)

According to Neal (1934), this species is precinctive to O'ahu, where it has been found to occur over a wide altitudinal range. She reports that these snails live on the ground on dead leaves and twigs; little is known of their vegetational preferences, although at one location the species was collected among *kukui* (*Aleurites*) trees. *Orobophana uberta* was formerly more widely distributed than today, and fossil or subfossil shells may be found in abundance in localities where, as at Barber's Point, the species is now extinct.

Family ASSIMINEIDAE

Assiminea nitida (Pease, 1865)

Assiminea nitida is an amphibious snail of wide distribution among the islands of the Indo-Pacific region. Kay (1979) reports Hawaiian representatives of the species to occur under rubble along the shoreline. Snails of this genus are usually associated with brackish water (Abbott 1958), as at Kualoa, O'ahu, where Christensen (unpublished observations) has found *A. nitida* to live in moderate abundance under rocks at the edge of a brackish pond.

Family ACHATINELLIDAE

Lamellidea spp.

Lamellidea gracilis (Pease, 1871) was represented in all samples examined; no other species of *Lamellidea* were identified with assurance in this material, but the immature or fragmentary nature of many of the specimens necessitates use of the less precise identification "*Lamellidea* spp." in the statistical analyses. *L. gracilis* occurs throughout the Hawaiian Islands at elevations of less than 1,000 ft (Cooke & Kondo 1960). It is one of the few native species able to survive in areas of exotic vegetation, and is a common component of the modern leaf litter fauna in the Barber's Point study area.

Tornatellides spp.

At least three species of *Tornatellides* are represented in the Barber's Point material. Possibly the most abundant of these is *T. macromphala* (Ancey, 1903), a species occurring on several of the main islands in the Hawaiian chain and apparently the only member of the genus now inhabiting the study area. Because of the difficulty of identifying immature or broken shells of this genus, no attempt has been made to differentiate the various species present in these samples. For purposes of ecological analysis all *Tornatellinidae* found are classified as "native extant" taxa, even though only one species is known to inhabit the Barber's Point region at present. We do not believe that this unavoidable oversimplification causes the importance of the "native extant" faunal element to be significantly overstated in any sample. Little is known of the ecological preferences of these species, although the presistence of *T. macrocephala* in a region of exotic vegetation is indicative of a rather broad tolerance of changing ecological conditions in that species.

Family AMASTRIDAE

Leptachatina (Angulidens) cookei Pilsbry, 1914

Fossil or subfossil shells of this species have been found in a few scattered locations in western O'ahu, in the arid coastal regions below the Wai'anae Mountains. *L. cookei* is now extinct. *Angulidens*, the subgenus to which both of the *Leptachatina* present in the Barber's Point deposits belong, is represented by one or more species on each of the main islands of the Hawaiian chain; nearly all of these are extinct taxa formerly inhabiting lowland areas (Pilsbry & Cooke 1915-16).

Some specimens of *Leptachatina*, undoubtedly representing this or the following species, are too immature or fragmentary for precise identification; they are listed in the data tables as "*Leptachatina* sp.".

Leptachatina (Angulidens) subcylindracea Cooke, 1911

Like the preceding species, *Leptachatina subcylindracea* is an extinct lowland snail; it was formerly widely distributed on O'ahu and has also been reported from Moloka'i and Kaho'olawe.

Amastridae (Unidentified)

Some apical fragments or very immature shells of amastrid snails cannot be assigned with certainty to any particular genus. Some may be of the species of *Leptachatina* represented in these deposits, while others may be a species of *Amastra* not otherwise found in our material. A few specimens of *Amastra (Cyclamastra) umbilicata* (Pfeiffer, 1855) were recovered from soil excavated by ARCH workers from Site 9670-P1, but the species was not identified in our samples from that or other sites.

Family VERTIGINIDAE

Lyropupa (Mirapupa) perlonga (Pease, 1871)

This species occurs abundantly in the fossil and subfossil deposits of coastal O'ahu; a subspecies is found on Ni'ihau and Kaua'i. Species of the subgenus *Mirapupa* are restricted to arid low-elevation sites (Pilsbry & Cooke 1918-20). Living individuals of *Lyropupa perlonga* are rarely encountered; the only live-collected Bishop Museum lot for which data on plant associations are available is BPBM 21939, containing numerous specimens found on *pili* grass (*Heteropogon*) at Koko Head, O'ahu, in 1911. Small numbers of *L. perlonga* were found living in leaf litter taken in the immediate vicinity of Site B6-78, a region of *kiawe* forest; the species is thus one of the few native snails tolerant of such disturbed conditions.

Nesopupa litoralis Cooke and Pilsbry 1920

This extinct species is known only from fossil or subfossil shells found in a few scattered localities on the O'ahu coastal plain (Pilsbry & Cooke, 1918-20).

Nesopupa newcombi (Pfeiffer, 1852)

This species has been reported from most of the main Hawaiian Islands. It is often found in lowland deposits, but also occurs in inland locations; its ecology is otherwise unknown. No living or freshly-dead shells of *Nesopupa newcombi* were found during the present study, and the species is apparently extinct in the Barber's Point region.

Family CHONDRINIDAE

Gastrocopta servilis (Gould, 1843)

This Neotropical species has been transported throughout the islands of the Pacific by modern commerce. It has been present in Hawai'i at least since 1892 (Ancey 1892), when specimens mistakenly believed to be indigenous to these islands were described as *Pupa lyonsiana* Ancey. *Gastrocopta servilis* is now the most abundant snail in the leaf litter fauna of the Barber's Point study area.

Family PUPILLIDAE

Pupoidopsis hawaiiensis Pilsbry and Cooke, 1921

Fossil and subfossil shells of *Pupoidopsis hawaiiensis* are often abundant in aeolian sandstones and other deposits in the coastal lowlands of the main Hawaiian Islands, but the species is thought to be extinct throughout the state. On Christmas Island, the only other location in which the species is known to occur, living snails have been found on the bunchgrass *Lepturus*, a habitat probably similar to that formerly occupied by *Pupoidopsis* in Hawai'i (Cooke & Neal 1928).

Family SUCCINEIDAE

Succinea spp.

The great majority of the succineids recovered from excavations in the Barber's Point area appear to be referable to *Succinea caduca* Mighels, 1845, a native species found throughout the main islands of Hawai'i in coastal, and often arid, locations; the species currently inhabits the study area, where estivating individuals can often by found in abundance sealed to the undersides of limestone blocks. The subfossil material examined exhibits a considerable range of shell forms, however, and Barber's Point succineids are here cited as "*Succinea* spp.", an imprecise determination necessitated by the confused taxonomic state of Hawaiian Succineidae and the difficulty encountered in making identifications in this group based solely upon shell characters.

Family ENDODONTIDAE

Cookeconcha n. sp.

These specimens are of an undescribed species of *Cookeconcha*, now extinct, that formerly inhabited the arid lowlands of the 'Ewa Plain.

Pilsbry and Vanatta (1906) stated that species of *Cookeconcha* "live on dead stumps and logs, and under the bark of dead trees, but also under fallen leaves." Solem (1976) added that these snails "have also been found in heavy moss on large boulders and at low levels on tree trunks." These remarks are probably more relevant to species of the mountain forests than to those of dryer low-elevation sites such as the current study area, most of which had become extinct prior to the activities of modern malacologists; the observation of undescribed species of *Cookeconcha* living in *pili* grass (*Heteropogon*) at Koko Head, O'ahu (BPBM 21938, collected 1911) and on the bunchgrass *Eragrostis* on the island of Nihoa (BPBM 54514 et seq., collected 1923) may be indicative of the preferred habitat of the Barber's Point species. It should be noted that *Lyropupa perlonga*, a species common in the Barber's Point samples, was found living in the company of the *Cookeconcha* species at the Koko Head location.

Endodonta n. sp.

The second endodontid snail present in the Barber's Point material is also an extinct species restricted to the Barber's Point-'Ewa Plain region. As with *Cookeconcha*, published ecological data are most pertinent to species from high-elevation or other moist environments; an exception is the report by Cooke (1928) of the occurrence of living *Endodonta* "in talus slopes of the Wai'anae Mountains, some of them in dry and exposed situations." An undescribed *Endodonta* was found living in company with *Cookeconcha* in bunchgrass on Nihoa (BPBM 57361 et seq., collected 1923), and the Barber's Point species may have occurred under similar conditions.

Family SUBULINIDAE

Lamellaxis gracilis (Hutton, 1834)

This adventive species, of uncertain geographical origins, is known to have become established in several island groups in Oceania prior to the advent of European influence in the Pacific (Christensen & Kirch 1980). Although no records of the occurrence of this species in Hawaiian archaeological sites of prehistoric age are known to use, we anticipate that *Lamellaxis gracilis* will be demonstrated to have reached these islands prior to A.D. 1778. It should be noted that in none of the sites examined during the current study do *Gastrocopta servilis* or *Pseudopeas tuckeri*, adventive snails introduced during the modern period, occur in stratigraphic levels below those marking the earliest occurrence in each site of *L. gracilis*.

A number of subfossil snail eggs of the type produced by *L. gracilis* were found. Several of these were opened, and contained embryonic shells of a subulinid species. As the only other subulinid found in the Barber's Point material (*Pseudopeas tuckeri*) is ovoviviparous and does not produce a shelled egg (Pilsbry 1906), each of these eggs has been counted as an individual of *L. gracilis*.

Lamellaxis gracilis is a resident of gardens and other disturbed habitats and may be an indicator of agricultural activities (Christensen & Kirch 1980). Although living individuals of this species are commonly found in such situations on O'ahu, no fresh shells of *L. gracilis* were found in leaf litter from Barber's Point.

This species has often been cited as *Opeas gracile*, and Solem (1978) reports that *Opeas oparanum* (Pfeiffer, 1845) is another synonym.

Pseudopeas tuckeri (Pfeiffer, 1846)

This poorly-known species, not previously reported to occur in the Hawaiian Islands, is an exotic snail undoubtedly introduced by modern commerce. Although empty shells of this species were found in leaf litter at Site B6-78, no living individuals were found there or at other sites. The shell of *Pseudopeas tuckeri* bears spiral-striate embryonic whorls and crenulate sutures, characters that distinguish this species from *Lamellaxis gracilis;* these features are indiscernible in worn shells and in some immature specimens, and at Site B6-78, where these species co-occured, shells not definitely referable to one of these species are listed in the table of data as "Subulinidae (unidentified)".

Incertae Sedis

A few shells, too incomplete or immature even for family-level determination, are listed in the tables of data as "unidentified."

RESULTS

Results of the analyses are presented below by individual site. For exhaustive site descriptions and analyses of stratigraphy, the reader is referred to the final excavation report by ARCH.

SITE OA-B6-78

This site, a large sinkhole with an opening 2.5 by 1.5 meters and a depth of 1.9 meters to the top of the deposit, was the subject of salvage excavations by Sinoto (1978:21-24). The sink's deposits yielded a large number of fossil birdbones, particularly in the upper 35 cm. Fortunately, the excavators left some intact deposit of the upper levels near the walls of the sink, and half of the lower breccia zone remains unexcavated. Thus, we were able to obtain a continuous column of nine samples (to 85 cm below the original sink floor).*

The site's stratigraphy was reported by Sinoto (1978:fig 11 and table 4), and was also the subject of a detailed sedimentary analysis by Morgenstein (1978). Unfortunately, the two accounts are discrepant in terms of layer designations and thicknesses, although they largely agree in description of the sediments. Sinoto's "overburden" is essentially Morgenstein's Layer I. Morgenstein's Layer II, the primary zone of birdbone deposition, is coincident with Sinoto's Layer I and part of Layer II (based on depth data presented in Sinoto's table 4). Morgenstein's Layer III is divided by Sinoto into Layers III and VI.

Based upon our field examination of the remaining portion of the stratigraphic column, we believe that Morgenstein's designations are sufficient to delineate the major stratigraphic units. The following is a summary of the depositional sequence, with depths as measured at the time of landsnail sample collection:

*Because we began sampling into the exposed face of the lower breccia zone (Layer III), before sampling the remnant upper levels, our sample numbers run in the following order from top to bottom of the stratigraphic column: 6,7,8,9,1,2,3,4,5.

Layer	Depth	Description
I	0-5 cm	Black (10YR 2/1)* organic A_0 and A_1 horizons, relatively loose.
II	5-35 cm	Brown (7.5YR 5/4) aeolian silt and alluvial sand with angular fragments of limestone. Primary zone of birdbones.
III	35-85+ cm	Reddish yellow (5YR 5/6) deposit of limestone breccia in a matrix of aeolian silt and alluvial sand.

The results of snail analysis are given in Table 2, and are plotted in Figure 2. It is apparent that the Layer I faunal assemblage is the most divergent of the entire set, with significantly reduced quantities of the native genera *Orobophana*, *Leptachatina*, *Cookeconcha*, and *Endodonta*. Abundant presence of the introduced *Gastrocopta* and *Pseudopeas* indicates that Layer I represents historic-period change.

Layer II (samples 7-9) is clearly a zone of change. During the depositional span of this stratum, there was significant decrease in *Cookeconcha*, and increases in *Lamellidea*, *Tornatellides*, *Lyropupa*, and *Succinea*. Most interestingly, the species *Lamellaxis gracilis* is present in the upper two-thirds of Layer II. This species was apparently spread throughout the inner Pacific by prehistoric Austronesian peoples (cf. Christensen and Kirch 1980), and its presence in Layer II would suggest that man was also active in the area by that time. Given that Layer II is the principal zone of fossil birdbone, this indication of human activity (however tentative) is of considerable interest.

Layer III shows a total absence of any introduced snail species, although there are changes in its faunal composition from top to bottom. These may represent local changes in vegetation, although we are not as yet able to suggest the precise nature of such floral change. The gradual increases in *Orobophana* and *Leptachatina* might indicate increasing vegetative cover.

The extent to which the faunal sequence graphed in Figure 2 is graded can be tested with the use of a similarity matrix, as described above. Proportional similarity values for the B6-78 samples are given in Table 3, and are plotted as a shaded matrix in Figure 3. The grading index (Q) for this matrix is 123 (Q = 0 for a perfectly graded matrix). The greatest possible Q value for any matrix is given by the formula:

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* Munsell Color Chart designation.

$$Q_{max} = \binom{n}{2}^2 - \sum_{j=1}^{n-1} j \binom{j+1}{2}$$

For a 9 x 9 matrix as with B6-78, Q_{max} = 546. The Q/Q_{max} ratio for site B6-78 is thus 0.23, which indicates that the stratigraphic sequence is definitely non-random (Pielou 1979:fig. 3), and reasonably well graded. Examination of the shaded matrix also reveals (1) the divergence of the Layer I assemblage, and (2) that there is slightly higher internal clustering between samples from Layers II and III, thus supporting the interpretation of the faunal succession in terms of the observed stratigraphic units. That is, within Layer III, Sample 2 links most closely with Samples 1 and 3 (above and below it), and within Layer II, Sample 8 links most closely with Samples 9 and 1, both lower in the column.

In sum, the landsnail sequence from site B6-78 can be interpreted as a non-random, reasonably well-graded faunal succession. Gradual changes in Layer III may represent local vegetational changes. More drastic change is indicated for Layer II (the fossil birdbone zone), and the possible role of humans is suggested by the presence of *Lamellaxis*. Historic-period changes are clearly evidenced by Layer I.

SITE 9670-P1

Site 9670-P1 is a large sinkhole about 3 to 4 meters in diameter and 3 meters deep. At the time of sampling for landsnails, the majority of the deposit had been excavated for fossil birdbones by the ARCH team. The landsnail column was taken from an undisturbed face in the center of the sink, about 1 meter from the limestone walls (adjacent to TP-4, E face). The stratigraphic profile was as follows:

Layer	Depth	Description
I	0-2 cm	A_0 and A_1 horizon of organic matter and litter.
II	2-23/24 cm	Silt-loam composed of aeolian material with fine limestone gravel. A reddish tint in the upper part of the deposit grades into a creamy color at the base.
III	23/24-27 cm	Compacted deposit of unconsolidated limestone breccia in cream-colored silt matrix.

Results of the landsnail analysis are given in Table 4 and plotted in Figure 4. It is evident that this series of samples represents a well-graded progression of faunal change. Most salient are the continual decreases in *Orobophana* and *Endodonta*, and the increases in *Lamellidea*, *Tornatellides*, and *Succinea*. The historically introduced *Gastrocopta* increases in abundance in the upper 7 cm (the presence of two specimens in the 7-12 cm sample probably derives from the contact zone of Samples 2 and 3). Most significantly, the prehistorically introduced *Lamellaxis* is present throughout the deposit, raising the question of the potential role of man in this sequence of faunal, and presumably vegetational, change.

The interpretation of the 9670-P1 stratigraphic column as a well-graded series is oorne out by matrix analysis (Table 5 and Figure 5). The grading index, Q, for this matrix is only 3, and the Q/Q_{max} ratio of 0.035 (Q_{max} = 85) indicates a highly significant non-random pattern.

SITE 2700-1A

This site is a habitation feature (see ARCH report for description), chosen for landsnail analysis in order to contrast the faunal assemblage of such an occupation site with those of the paleontological sink deposits. The sampling column was cut from the E face of the SE quadrat of grid unit N1/E1. The stratigraphic profile at this point was as follows:

Layer	Depth	Description
---	0-3 cm	A_0 horizon; organic litter.
---	3-6 cm	A_1 horizon. Overburden of aeolian dust and organic matter. Very dark gray (5YR 3.1).
I	6-7/9 cm	Gray to light gray (5YR 5-7/1) cultural deposit, color becoming lighter with increasing depth. Compacted, with marine shells and other midden material.
	[7/9-11 cm	Irregular contact zone between Layers I-II; landsnails very abundant.]
II	7/9-27 cm	Culturally sterile, decomposed limestone; compacted; gravelly. Light gray (5YR 7/1).

Results of the landsnail analysis are presented in Table 6 and are plotted in Figure 6. The faunal sequence indicates rather drastic changes beginning with the onset of human habitation. The Layer II assemblage correlates fairly closely with the upper part of Layer III in Site B6-78. With the beginning of habitation, there is a major decrease in *Orobophana* and *Leptachatina*, increases in *Lamellidea* and *Lyropupa*, and the significant addition of *Tornatellides* and *Succinea*. The Polynesian introduction *Lamellaxis* also appears (the presence of a few *Gastrocopta* could be due to contamination from upper levels during sampling). Following abandonment of the habitation site, further change occurred, including continued increases in *Lamellidea* and *Tornatellides*, drastic decrease in *Orobophana*, extirpation of *Leptachatina*, and major increase in *Gastrocopta*. The influence of man on the local ecology seems unquestionable in the present case. Interestingly, the pattern of change in this habitation site largely mirrors that in the upper portions of the two birdbone-bearing limestone sinks.

SITE 2701-1

This is a small C-shaped shelter built of limestone slabs, with an interior floor area of ca. 4 m^2, on open limestone. A 50-cm^2 test pit had been excavated by the ARCH team, exposing a thin cultural deposit with limited quantities of shellfish and bone midden. The stratigraphic column was as follows:

Depth	Description
0-3 cm	A_0 horizon; organic litter.
3-8 cm	A_1 horizon and zone of cultural material; light gray.
8-13/20 cm	Decomposed limestone distributed in pockets in the limestone bedrock.

Results of landsnail analysis are reported in Table 7 and plotted in Figure 7. The sequence of faunal change closely parallels that described for Site 2700-1A. (It is doubtful, however, that *Gastrocopta* should really be associated with the prehistoric cultural deposit. In this case the shallow and loose nature of the stratigraphic column may have resulted in some mixing.)

Site 2701-3

The final site chosen for snail analysis is a small sinkhole, ca. 2 to 3 meters in diameter and 0.5 to 0.75 meter deep, with a low wall of limestone slabs built up on the E edge of the sink. The ARCH team had excavated a 25-cm^2 test pit into the floor of the sink, and had judged the feature to be culturally sterile. A column of three samples was taken for comparison with the deep, birdbone-bearing sinks and with the habitation sites. The stratigraphic profile was as follows:

Depth	Description
0-10 cm	A_0 and A_1 horizons. Gravelly soil with charcoal flecks. Very dark gray.
10-16/17 cm	Compacted, transitional zone from dark organic layer into decomposed limestone floor of sink.

Results of snail analysis are reported in Table 8 and plotted in Figure 8. This faunal sequence contrasts markedly with those from all other sites, with samples composed of 88 to 98% *Assiminea nitida*, an amphibious snail normally associated with brackish-water environments. While the occasional presence of shells of this species in a site may be due to random wandering by these snails (they may not be absolutely tied to water), the great abundance of *Assiminea* at Site 2701-3 is not explicable by chance contamination. Furthermore, there is no evidence to suggest that this shallow sink was ever permanently flooded. Therefore, we propose the hypothesis that this faunal assemblage indicates transport by man of mud (perhaps with weeds for mulch) from a nearby brackish-water pond for the purpose of improving soil quality in a region of barren limestone rock. Such an hypothesis would be consistent with ethnohistorical accounts of Hawaiian agronomic practices, and would fit with the low wall along the sink edge (as a windbreak). In the future, it would be interesting to see if other shallow sinks in the area exhibit similar soil profiles.

GENERAL DISCUSSION

Having reviewed the specific results for each of the five sites studied, we may now turn to a discussion of the wider implications. In this discussion, we are particularly concerned with (1) tentative temporal correlations between the stratigraphic columns, (2) the implications for patterns of ecological change in the Barber's Point area, and (3) the possible role of man--both prehistoric and historic--in initiating or hastening such ecological change.

Inter-Site Correlations

Although there are differences in the stratigraphic columns of the sites studied, the overall pattern of faunal change is remarkably consistent, and allows us to propose tentative temporal correlations between columns. Major time markers for this purpose include: (1) the onset of major decreases in *Orobophana, Leptachatina, Cookeconcha,* and *Endondonta*; (2) the onset of significant increases in the genera *Lamellidea, Tornatellides, Lyropupa,* and *Succinea*; (3) the appearance of the putative Polynesian introduction *Lamellaxis gracilis*; and (4) the appearance of the historically introduced *Gastrocopta* and *Pseudopeas*.

Figure 8 diagrams our proposed correlations of stratigraphic columns, based upon the landsnail evidence. It is evident that Site B6-78 provides the longest stratigraphic sequence, and is thus of critical importance in assessing long-term ecological change in the area. The column in Site 9670-P1 appears to us to correlate with the upper portion of Site B6-78. The two habitation sites probably span a lengthy time period, as suggested in the diagram, but their stratigraphic sections are greatly compressed and not as amenable to detailed analysis.

Based upon the presence/absence of the introduced snail species, it is possible to suggest that the temporal sequence shown in Figure 8 spans three major periods: (1) a pre-human-contact period; (2) a period of prehistoric Polynesian utilization/occupation of the area; and (3) the recent historic period. The rate and extent of ecological change can be seen, from an examination of the landsnail diagrams themselves, to have increased and intensified from periods 1 to 3. Most significant of all is the implication that Polynesian man was present in the area at the time that the majority of avian remains were deposited. The possible role of humans in the extinction of these birds--whether direct, indirect, or both--is thus raised.

We must stress, at this point, that our tentative correlations are based solely on the landsnail evidence presented above, and have not had the benefit of any "absolute" dating. While the consistency in patterning of faunal successions between sites gives us some confidence in the proposed correlations, they could be subject to revision based upon the results of a dating program. We feel that such a program of careful and extensive dating--using radiocarbon, amino-acid racemization, flourine, or other techniques (preferably several methods to cross-check each other)--is of utmost priority at the present time. Only such absolute age determinations will decisively answer the question of whether the extinction of the Barber's Point avifauna occurred during the span of human occupation of these islands.

Patterns of Ecological Change

Paleoecological analysis based upon the occurrence of landsnails in the earliest levels of the Barber's Point sites (i.e., those which presumably pre-date human occupation of the region) is hindered by our as yet incomplete knowledge of the ecological templates of the various species present. A number of those species most characteristic of these early levels are now extinct, making direct observation of their habitat preferences impossible. Data regarding other species are often imprecise, since malacological studies of Hawaiian terrestrial snails have for more than a century been focused upon taxonomy, with little more than passing consideration of ecology. Nevertheless, it is possible to make certain inferences regarding the general nature of the paleo-environment of the study area prior to its more recent modification by man or other agency.

Possibly the most important evidence is the absence, not only in the early levels but throughout the sequence, of any snails characteristic of moist forest conditions. Such taxa as *Achatinella, Auriculella, Amastra* (excluding the xerophilous subgenus *Cyclamastra*), *Laminella*, *Lyropupa* of the nominate subgenus, low-spired Succineidae (principally *Catinella*), and *Philonesia* are not represented in any of the sites studied. Although this is negative evidence, all of these occur in forested locations in the nearby Wai'anae Mountains, and several (*Achatinella*, *Catinella*, and *Philonesia*) are abundantly represented in coastal deposits in windward O'ahu, where they presumably indicate that moist forest conditions formerly extended to elevations considerably lower than those to which such environments are now limited in that region (cf. Perkins 1913:xxvi-xxvii).

In contrast, the Barber's Point assemblage conveys the impression of relative aridity, and of a flora characterized by native grasses, shrubs, and possibly sparse dry-forest, open-canopy tree species (such as *Erythrina*, *Myoporum*, or *Reynoldsia*).* The dominant snail species in the early levels of the Barber's Point sites would be--as far as our limited ecological data indicate--entirely consistent with such a reconstruction. *Pupoidopsis hawaiiensis*, a rare species in our samples, was probably restricted to grasses in coastal locations; the species is now extinct in Hawai'i, but was known to inhabit clumps of bunchgrass (*Lepturus* sp.) on Christmas Island (Cooke & Neal 1928). *Leptachatina cookei*, *L. subcylindracea*, and *Nesopupa litoralis* are universally extinct and their ecological preferences are therefore not directly observable, but their occurrence only in low-elevation fossil deposits, including the dry leeward coast of O'ahu, is indicative of a partiality for arid conditions. *Cookeconcha* n. sp. and *Endodonta* n. sp. are likewise universally extinct, but the only closely related species found living at low elevations were found on grasses in arid locations. *Orobophana* seems to prefer some degree of shrub or tree cover, and has been collected on dead leaves and twigs (Neal 1934). *Nesopupa newcombi* and *Tornatellides* spp. (the first not now living in the Barber's Point region but persisting elsewhere on O'ahu; the second represented in the modern fauna of the area by a single species) are apparently tolerant of a rather broad range of environmental conditions, but are not inconsistent with the arid grassland-parkland conditions postulated for the area prior to human disturbance.

Later levels of the Barber's Point sites are characterized by a rather different landsnail assemblage, dominated first by native taxa tolerant of disturbed conditions (as evidenced by their presence in the modern fauna of the area), such as *Lamellidea*, *Tornatellides*, *Lyropupa*, and *Succinea*. The first two are frequently collected in disurbed vegetation (Cooke & Kondo 1960). *Lyropupa* is tolerant of very arid conditions, and Pilsbry and Cooke (1918-20: 259) remarked: "In every case where the junior author found living examples they were taken in open country under dead sticks and stones." *Succinea* can tolerate very dry conditions indeed. Thus, while tentative, we may have

*In this regard, it is interesting to note the continued presence in the Barber's Point area of the endemic, xerophytic shrub *Euphorbia skottsbergii* Sherff, probably a survival from earlier times.

evidence in the Barber's Point faunal sequence of increasing aridity and decreasing vegetative cover.

In the upper levels of the sites exotic snails also appear, becoming dominant in the topmost levels. This transition from a fauna of exclusively native taxa, many of them now extinct in the Barber's Point area, to a fauna in which exotic forms predominate, may be recognized in all of the sites studied. In the absence of radiocarbon or amino-racemization dates indicating the contemporaneity of this transition with the advent of human occupation, it is perhaps premature to conclude with certainty that man was responsible (through forest clearance and agriculture) for the extinction of much of the native landsnail fauna (and avifauna?). We believe, however, that such dates, when available, will be consistent with this conclusion.

In sum, the overall patterns of ecological change suggested by the evidence of landsnail analysis are of a pre-human-contact, grassland-parkland vegetation, giving way to increased aridity and decreased vegetative cover, possibly as a result of prehistoric Polynesian interference, and finally, to rather drastic change in local flora and fauna in historic times.

CONCLUSION AND RECOMMENDATION

The results reported above represent the first major application of paleo-malacological analysis to Hawaiian archaeological (and in this case paleontological) sites. We believe that our cautious optimism that such analysis could provide significant information on paleo-ecology has been vindicated. In the Barber's Point case, we have been able to document consistent patterns of faunal succession that are doubtless a reflection of wider environmental changes in vegetation and other biota. Far more significant, we now have evidence--albeit tentative--for the presence of Polynesian man in the area at the time of deposition of the fossil birdbones.

If a complete picture of paleo-environmental change in the region--including the problem of man's role--is to be achieved, we feel that further paleo-malacological analysis is imperative. So far, only Site B6-78 has yielded a relatively lengthy stratigraphic sequence. Other deep sites need to be located and carefully sampled, in order to confirm or revise the pattern of ecological change outlined above. We recommend that as additional salvage excavations are conducted, paleo-malacological analysis be included as an integral part of the field and laboratory studies. We also stress that a program of radiocarbon and other direct dating of these stratigraphic profiles be undertaken as soon as possible. The wealth of avifaunal materials in the Barber's Point sites has justifiably created scientific excitement; the probability of their association with prehistoric man is a problem worthy of our best analytical efforts.

ACKNOWLEDGEMENTS

We wish to acknowledge Dr. Y. Kondo for graciously permitting us access to the collections and laboratory facilities of the Division of Malacology, B. P. Bishop Museum. Our ultimate debt is to Dr. Montague Cooke, Jr., who over half a century amassed the collections upon which all work in Hawaiian malacology must be based.

Table 2.

LANDSNAIL SAMPLE DATA FOR SITE OA-B6-78

Sample No.	6		7		8		9		1		2
Layer	OB		I		I		I		II		II
Depth	0-5		0-10		10-20		20-30		30-40		40-50
Dry Weight (g)	247.9		354.6		460.0		176.3		419		351.7
Weight of 4 mm frac. (g)	80.8	33%	136.7	39%	237.3	52%	98.0	56%	274.9	66%	149.5
Weight of 1 mm frac. (g)	69.6*		40.4		52.9		18.9		34.7		57.0
Total Snails Counted	4950		1311		2056		536		256		207
Snails/100 g	1997		370		447		304		61		59
	N	%	N	%	N	%	N	%	N	%	N
NE *Orobophana uberta*	385	7.8	203	15.5	325	15.8	91	17.0	55	21.5	45
FW *Assiminea nitida*	--	--	--	--	2	0.1	--	--	--	--	--
NL *Lamellidea* spp.	1212	24.5	219	16.7	308	15.0	65	12.1	32	12.5	30
NL *Tornatellides* spp.	508	10.3	112	8.5	43	2.1	5	0.9	--	--	--
NE *Leptachatina cookei*	23	0.5	18	1.4	32	1.6	3	0.6	3	1.2	--
NE *L. subcylindracea*	209	4.2	231	17.6	459	22.3	103	18.2	58	22.7	35
NE *L.* sp.	--	--	--	--	--	--	--	--	--	--	--
NE Amastridae (unident.)	--	--	--	--	--	--	--	--	--	--	--
NL *Lyropupa perlonga*	465	9.4	55	4.2	16	0.8	3	0.6	2	0.8	--
NE *Nesopupa litoralis*	75	1.5	10	0.8	30	1.5	18	3.4	7	2.7	4
I *Gastrocopta servilis*	424	8.6	1[a]	0.1	--	--	--	--	--	--	--
NE *Pupoidopsis hawaiiensis*	38	0.8	2	0.2	2	0.1	1	0.2	--	--	--
NL *Succinea* spp.	758	15.3	44	3.4	12	0.6	7	1.3	--	--	+
NE *Cookeconcha* n. sp.	220	4.4	273	20.8	586	28.5	180	33.6	69	27.0	53
NE *Endodonta* n. sp.	139	2.8	137	10.5	236	11.5	60	11.2	32	12.5	40
I *Lamellaxis gracilis*	236	4.8	2	0.2	4	0.2	--	--	--	--	--
I *Pacilopeas tuckeri*	145	2.9	3	0.2	--	--	--	--	--	--	--
I Subulinidae (unident.)	113	2.3	1	0.1	--	--	--	--	--	--	--
UNIDENTIFIED	--	--	--	--	1	0	--	--	--	--	--

*Weight of total 1 mm fraction; smaller sub-sample of 28.9 g sorted for snails.

[a]Possible contaminant.

Abbreviations: NE = native, extinct; NL = native, extant; I = introduced; FW = freshwater, extinct;

Table 2.

AIL SAMPLE DATA FOR SITE OA-B6-78

	8		9		1		2		3		4		5	
	I		I		II		II		II		II		II	
	10-20		20-30		30-40		40-50		50-60		60-70		70-80	
	460.0		176.3		419		351.7		500		707.9		230	
9%	237.3	52%	98.0	56%	274.9	66%	149.5	43%	328.6	66%	533.0	75%	116.4	51%
	52.9		18.9		34.7		57.0		49.8		42.7		36.6	
	2056		536		256		207		197		351		752	
	447		304		61		59		39		50		327	

	N	%	N	%	N	%	N	%	N	%	N	%	N	%
.5	325	15.8	91	17.0	55	21.5	45	21.7	40	20.3	60	17.1	109	14.5
	2	0.1	--	--	--	--	--	--	--	--	--	--	--	--
.7	308	15.0	65	12.1	32	12.5	30	14.5	28	14.2	52	14.8	159	21.1
.5	43	2.1	5	0.9	--	--	--	--	1	0.5	4	1.1	9	1.2
.4	32	1.6	3	0.6	3	1.2	--	--	--	--	7	2.0	12	1.6
.6	459	22.3	103	18.2	58	22.7	35	16.9	29	14.7	34	9.7	29	3.9
	--	--	--	--	--	--	--	--	--	--	--	--	8	1.1
	--	--	--	--	--	--	--	--	--	--	--	--	10	1.3
.2	16	0.8	3	0.6	2	0.8	--	--	3	1.5	9	2.6	48	6.4
.8	30	1.5	18	3.4	7	2.7	4	1.9	1	0.5	7	2.0	43	5.7
.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
.2	2	0.1	1	0.2	--	--	--	--	--	--	--	--	--	--
.4	12	0.6	7	1.3	--	--	+	+	1	0.5	--	--	2	0.3
.8	586	28.5	180	33.6	69	27.0	53	25.6	59	29.9	91	25.9	190	25.3
.5	236	11.5	60	11.2	32	12.5	40	19.3	34	17.3	87	24.8	132	17.6
.2	4	0.2	--	--	--	--	--	--	--	--	--	--	--	--
.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--
.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	1	0	--	--	--	--	--	--	1	--	--	--	--	--

28.9 g sorted for snails.

tant; I = introduced; FW = freshwater, extinct; NL = native, extant.

23

2

Table 3.

PROPORTIONAL SIMILARITY MATRIX FOR SITE B6-78

Sample Nos.

6	7	8	9	1	2	3	4	5	Sample Nos.
	0.54	0.40	0.36	0.35	0.35	0.36	0.40	0.50	6
		0.85	0.81	0.80	0.79	0.79	0.77	0.74	7
			0.90	0.93	0.86	0.87	0.83	0.76	8
				0.89	0.85	0.87	0.80	0.73	9
					0.91	0.88	0.82	0.73	1
						0.93	0.88	0.78	2
							0.87	0.78	3
								0.83	4
									5

Table 4.

LANDSNAIL SAMPLE DATA FOR SITE 9670-P1

Sample No.	1	2	3	4	5	6
Layer						
Depth	0-2	2-7	7-12	12-17	17-22	22-23/24
Dry Weight (g)	62.0	208.3	145.9	97.7	98.0	56.7
Weight of 4 mm frac. (g)	12.6	48.6	33.0	21.7	24.8	11.5
Weight of 1 mm frac. (g)	8.5	26.6	26.7	22.0	20.5	9.3
Total Snails Counted	374	1613	1759	1560	889	262
Snails/100 g	603	774	1205	1597	907	462

	N	%	N	%	N	%	N	%	N	%	N	%
NE *Orobophana uberta*	43	11.5	236	14.6	328	18.6	306	19.6	225	25.3	70	26.7
FW *Assiminea nitida*	1	0.3	1	0.1	1	0.1	1	0.1	--	--	2	0.8
NL *Lamellidea* spp.	68	18.2	349	21.6	339	19.3	305	19.6	147	16.5	36	13.7
NL *Tornatellides* spp.	53	14.2	346	21.5	330	18.8	291	18.7	93	10.5	15	5.7
NE *Leptachatina cookei*	--	--	--	--	8	0.5	9	0.6	3	0.3	--	--
NE *L. subcylindracea*	14	3.7	47	2.9	94	5.3	112	7.2	55	6.2	9	3.4
NE Amastridae (unident.)	--	--	+	+	+	+	--	--	--	--	2	0.8
NL *Lyropupa perlonga*	21	5.6	60	3.7	115	6.5	87	5.6	33	3.7	12	4.6
NE *Nesopupa litoralis*	--	--	10	0.6	4	0.2	16	1.0	12	1.3	2	0.8
NE *N. newcombi*	18	4.8	75	4.6	53	3.0	16	1.0	12	1.3	3	1.1
I *Gastrocopta servilis*	46	12.3	69	4.3	2	0.1	--	--	--	--	--	--
NE *Pupoidopsis hawaiiensis*	5	1.3	21	1.3	27	1.5	11	0.7	4	0.4	1	0.4
NL *Succinea* spp.	20	5.3	120	7.4	63	3.6	26	1.7	22	2.5	3	1.1
NE *Cookeconcha* n. sp.	18	4.8	52	3.2	85	4.8	73	4.7	64	7.2	9	3.4
NE *Endodonta* n. sp.	52	13.9	168	10.4	297	16.9	304	19.5	216	24.3	93	35.5
I *Lamellaxis gracilis*	15	4.0	59	3.7	11	0.6	3	0.2	3	0.3	4	1.5
UNIDENTIFIED	--	--	--	--	2	0.1	--	--	--	--	1	0.4

Abbreviations: NE = native, extinct; NL = native, extant; I = introduced; FW = freshwater.

Table 5.

PROPORTIONAL SIMILARITY MATRIX FOR SITE 9670-P1

Sample Nos.

2	3	4	5	6	Sample Nos.
0.83	0.81	0.75	0.69	0.61	1
	0.82	0.77	0.67	0.59	2
		0.94	0.82	0.70	3
			0.85	0.74	4
				0.83	5

Table 6.

LANDSNAIL SAMPLE DATA FOR SITE 2700-1A

Sample No.	1	2	3	4	5
Layer					
Depth (cm)	0-3	3-6	6-7/9	7/9-18	18-27
Dry Weight (g)	59.1	100.1	250.4	99.1	112.4
Weight of 4 mm frac. (g)	15.4	36.2	104.0	4.3	8.2
Weight of 1 mm frac. (g)	5.5	10.3	18.0	7.7	5.9
Total Snails Counted	218	132	318	183	33
Snails/100 g	369	132	127	185	30

	N	%	N	%	N	%	N	%	N	%
NE *Orobophana uberta*	5	2.3	5	3.8	111	34.9	89	48.6	16	48.5
NL *Lamellidea* spp.	58	26.6	44	33.3	69	21.7	30	16.4	5	15.2
NL *Tornatellides* spp.	28	12.8	14	10.6	12	3.8	--	--	--	--
NE *Leptachatina cookei*	--	--	--	--	11	3.5	11	6.0	+	+
NE *L. subcylindracea*	--	--	--	--	14	4.4	28	15.3	--	--
NE *L.* sp.	1	0.5	--	--	--	--	--	--	--	--
NL *Lyropupa perlonga*	+	+	1	0.8	41	12.9	8	4.4	2	6.1
NE *Nesopupa litoralis*	--	--	--	--	6	1.9	--	--	--	--
I *Gastrocopta servilis*	110	50.5	58	43.9	3	0.9	--	--	--	--
NL *Succinea* spp.	16	7.3	10	7.6	28	8.8	--	--	--	--
NE *Cookeconcha* n. sp.	--	--	--	--	2	0.6	2	1.1	--	--
NE *Endodonta* n. sp.	+	+	--	--	19	6.0	13	7.1	7	21.2
I *Lamellaxis gracilis*	--	--	--	--	1	0.3	--	--	--	--
UNIDENTIFIED	--	--	--	--	1	0.3	2	1.1	--	--

Abbreviations: NE = native, extinct; NL = native, extant; i = introduced;
FW = freshwater.

Table 7.

LANDSNAIL SAMPLE DATA FOR SITE 2701-1

Sample No.	1		2		3	
Layer						
Depth	0-3		3-8		8-13/20	
Dry Weight (g)	44.2		120.2		64.5	
Weight of 4 mm frac. (g)	11.7		32.7		9.1	
Weight of 1 mm frac. (g)	7.9		13.2		5.3	
Total Snails Counted	160		603		112	
Snails/100 g	362		502		174	
	N	%	N	%	N	%
NE *Orobophana uberta*	1	0.6	+	+	12	10.7
FW *Assiminea nitida*	--	--	3	0.5	1	0.9
NL *Lamellidea* spp.	28	17.5	198	32.8	27	24.1
NL *Tornatellides* spp.	33	20.6	245	40.6	19	17.0
NE *Leptachatina cookei*	--	--	--	--	5	4.5
NE *L. subcylindracea*	--	--	--	--	4	3.6
NE *L.* sp.	--	--	+	+	--	--
NL *Lyropupa perlonga*	+	+	19	3.2	19	17.0
I *Gastrocopta servilis*	79	49.4	82	13.6	5	4.5
NL *Succinea* spp.	16	10.0	55	9.1	20	17.9
UNIDENTIFIED	3	1.9	1	0.2	--	--

Abbreviations: NE = native, extinct; NL = native, extant; I = introduced;
FW = freshwater.

Table 8.

LANDSNAIL SAMPLE DATA FOR SITE 2701-3

Sample No.	1		2		3	
Layer						
Depth	0-5		5-10		10-16/17	
Dry Weight (g)	168.1		159.5		100.3	
Weight of 4 mm frac.(g)	102.1		88.7		23.4	
Weight of 1 mm frac.(g)	24.7		25.4		17.3	
Total Snails Counted	365		893		1180	
Snails/100 g	217		560		1176	
	N	%	N	%	N	%
NE *Orobophana uberta*	3	0.8	9	1.0	5	0.4
FW *Assiminea nitida*	321	87.9	818	91.6	1162	98.5
NL *Lamellidea* spp.	6	1.6	21	2.4	8	0.7
NL *Tornatellides* spp.	22	6.0	26	2.9	3	0.3
NE *Leptachatina cookei*	--	--	1	0.1	--	--
NE *L. subcylindracea*	2	0.5	4	0.4	--	--
NE *L.* sp.	--	--	--	--	+	+
NL *Lyropupa perlonga*	1	0.3	4	0.4	--	--
I *Gastrocopta servilis*	4	1.1	2	0.2	--	--
NL *Succinea* spp.	2	0.5	8	0.9	2	0.2
NE *Endodonta* n. sp.	+	+	+	+	--	--
UNIDENTIFIED	4	1.1	--	--	--	--

Abbreviations: NE = native, extinct; NL = native, extant; I = introduced; FW = freshwater.

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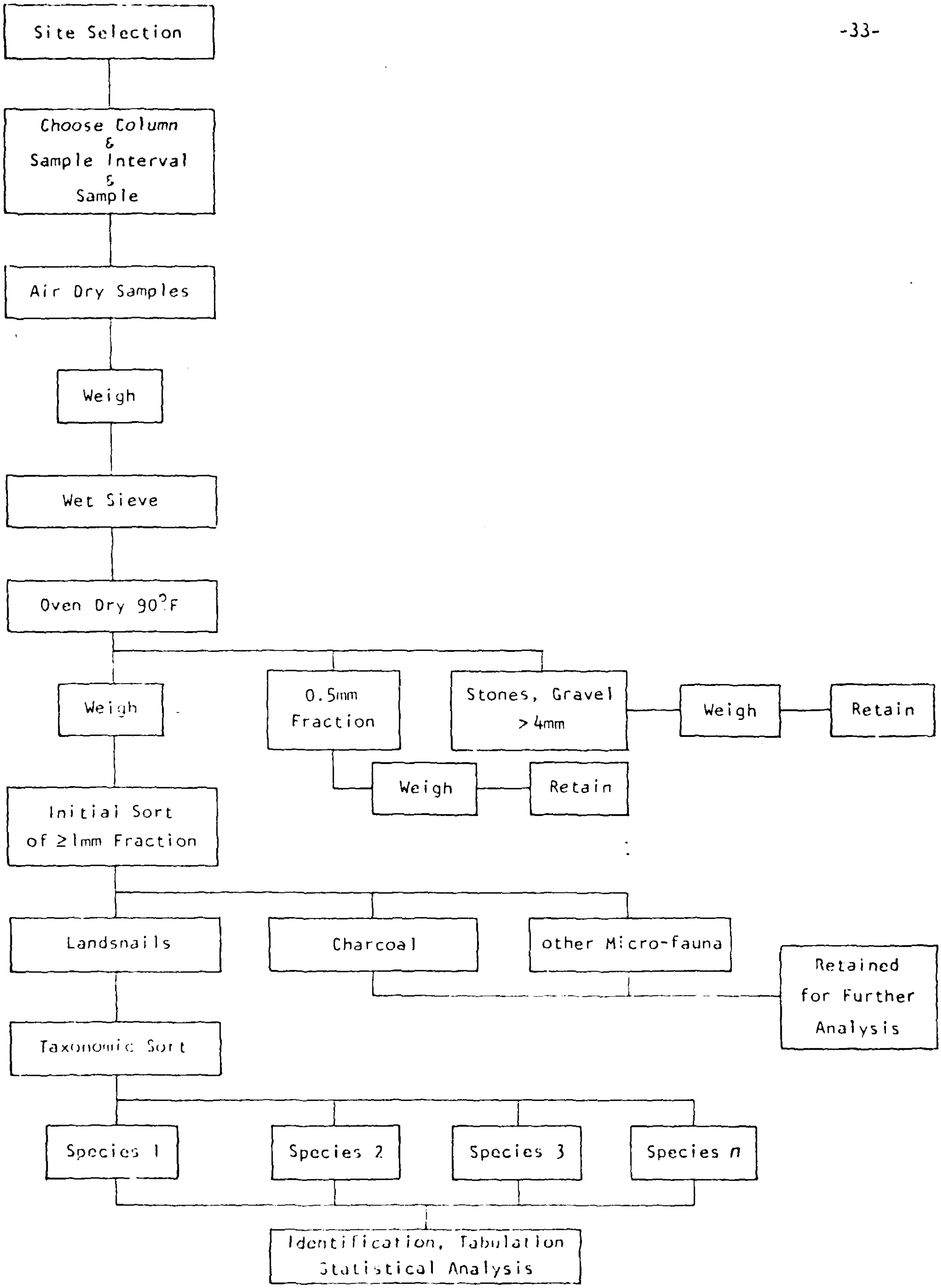


FIGURE 1 FLOW CHART ILLUSTRATING FIELD AND LABORATORY PROCEDURES USED IN BARBER'S POINT LANDSNAIL ANALYSIS.

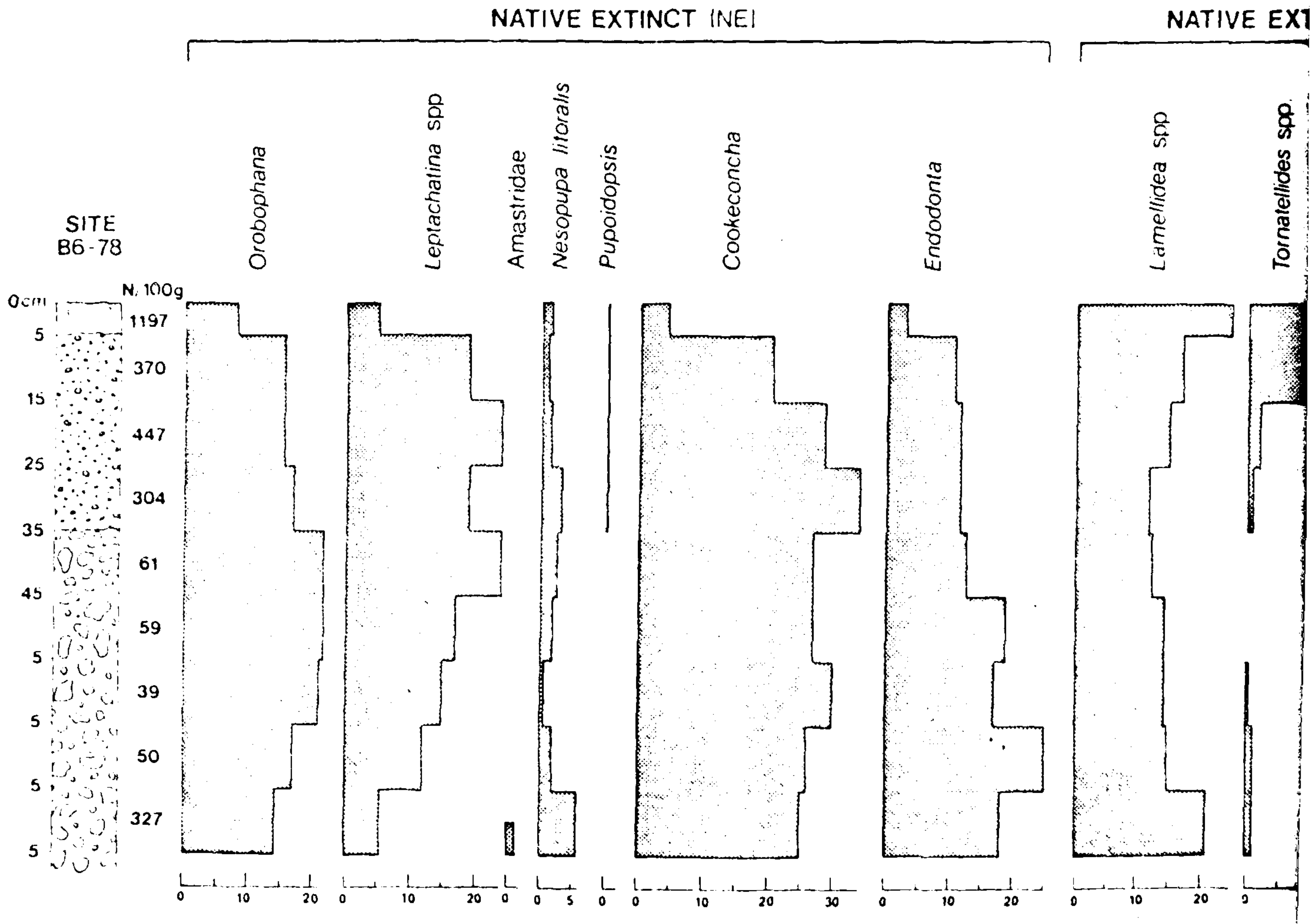
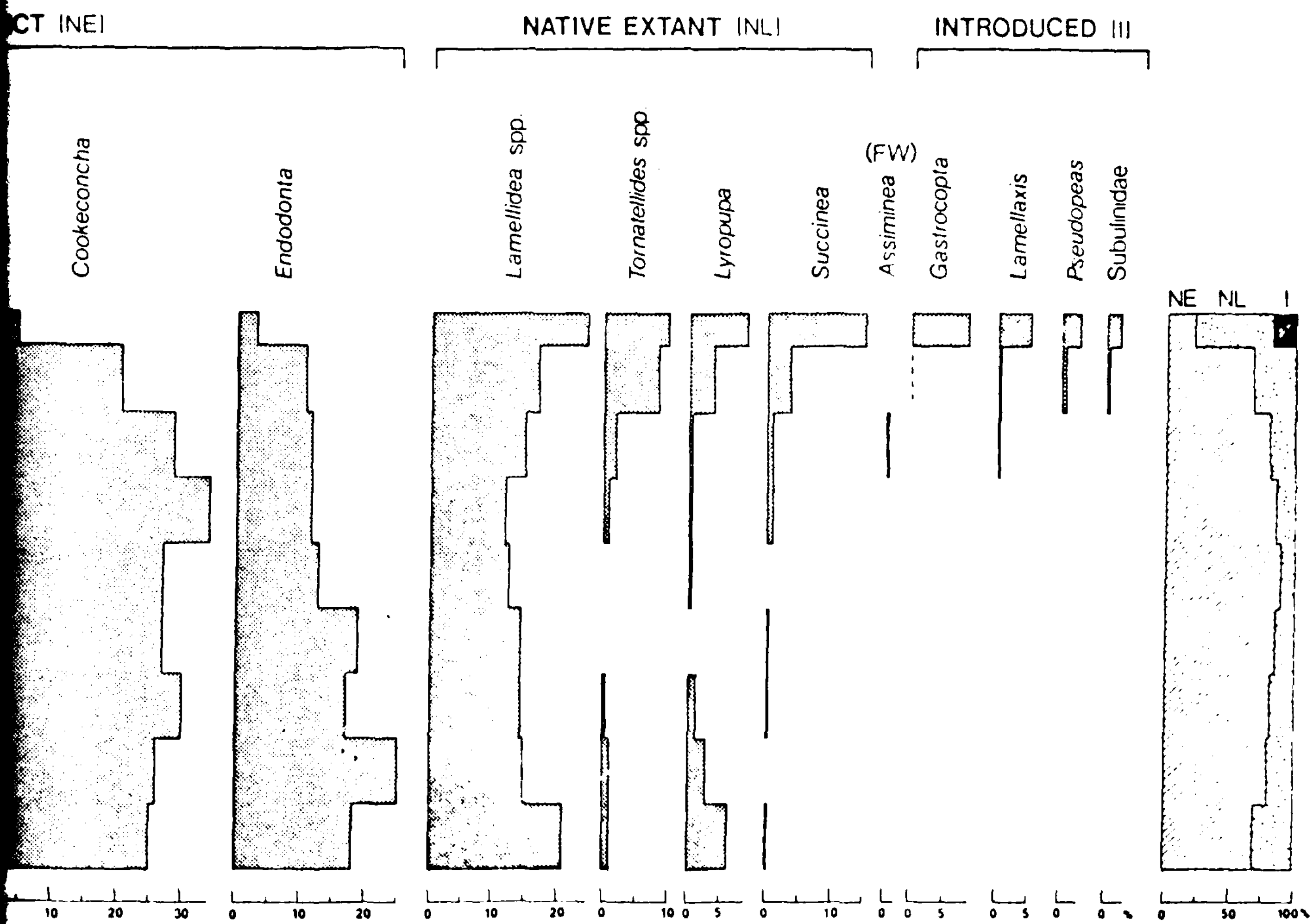


FIGURE 2 LANDSNAIL DIAGRAM FOR SITE OA-B6-78.



LANDSNAIL DIAGRAM FOR SITE OA-B6-78.

34

2

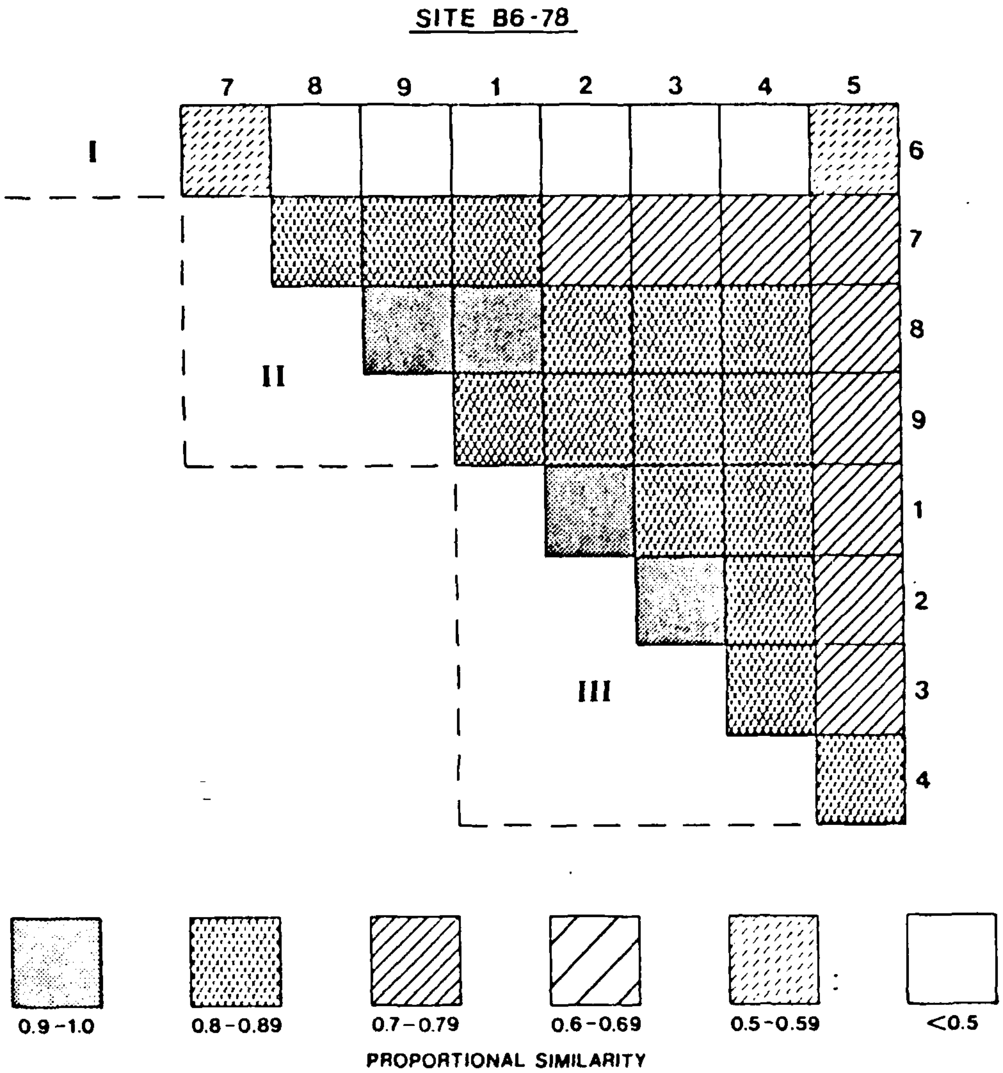


FIGURE 3 PROPORTIONAL SIMILARITY MATRIX FOR SITE OA-B6-78.

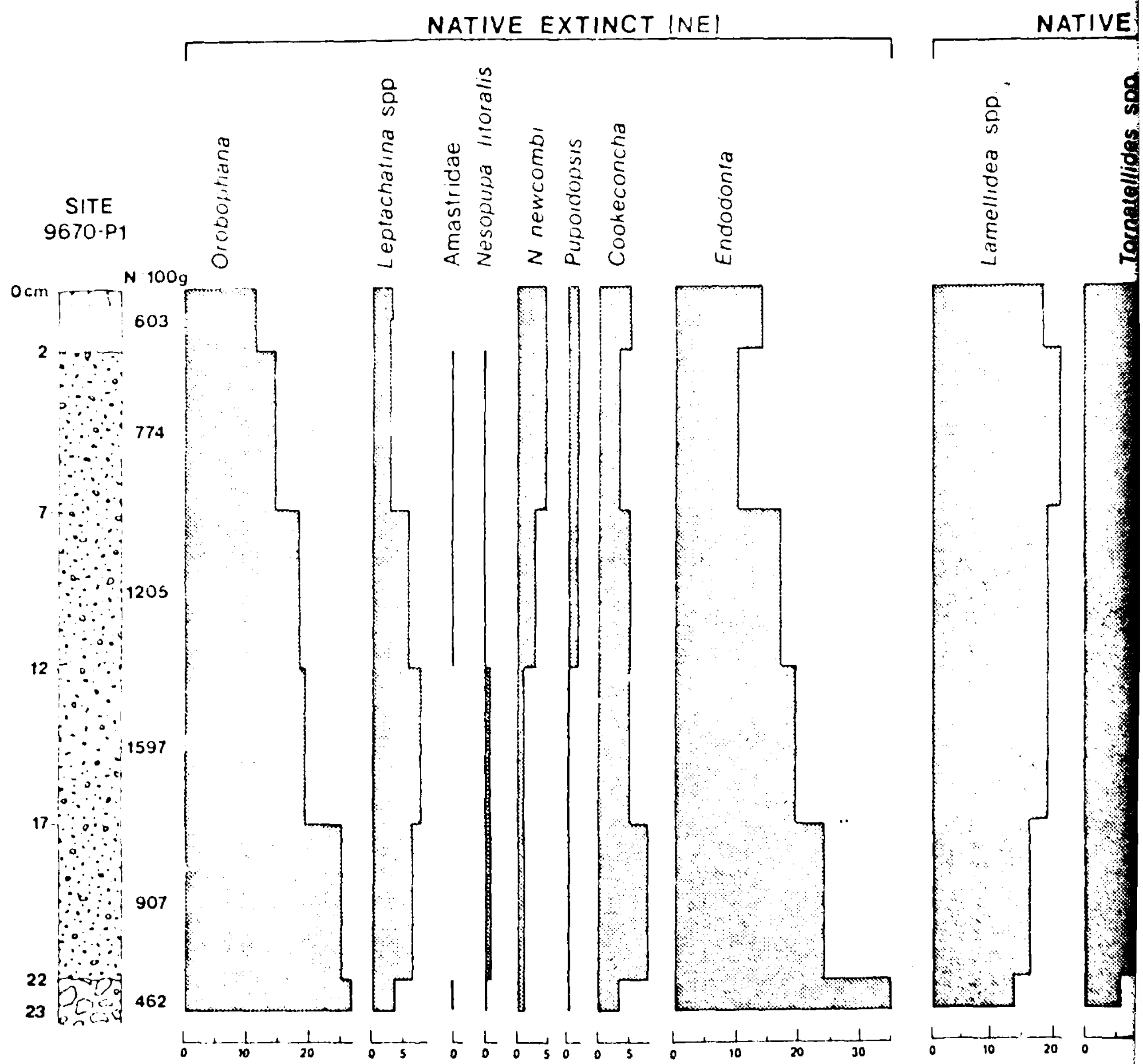
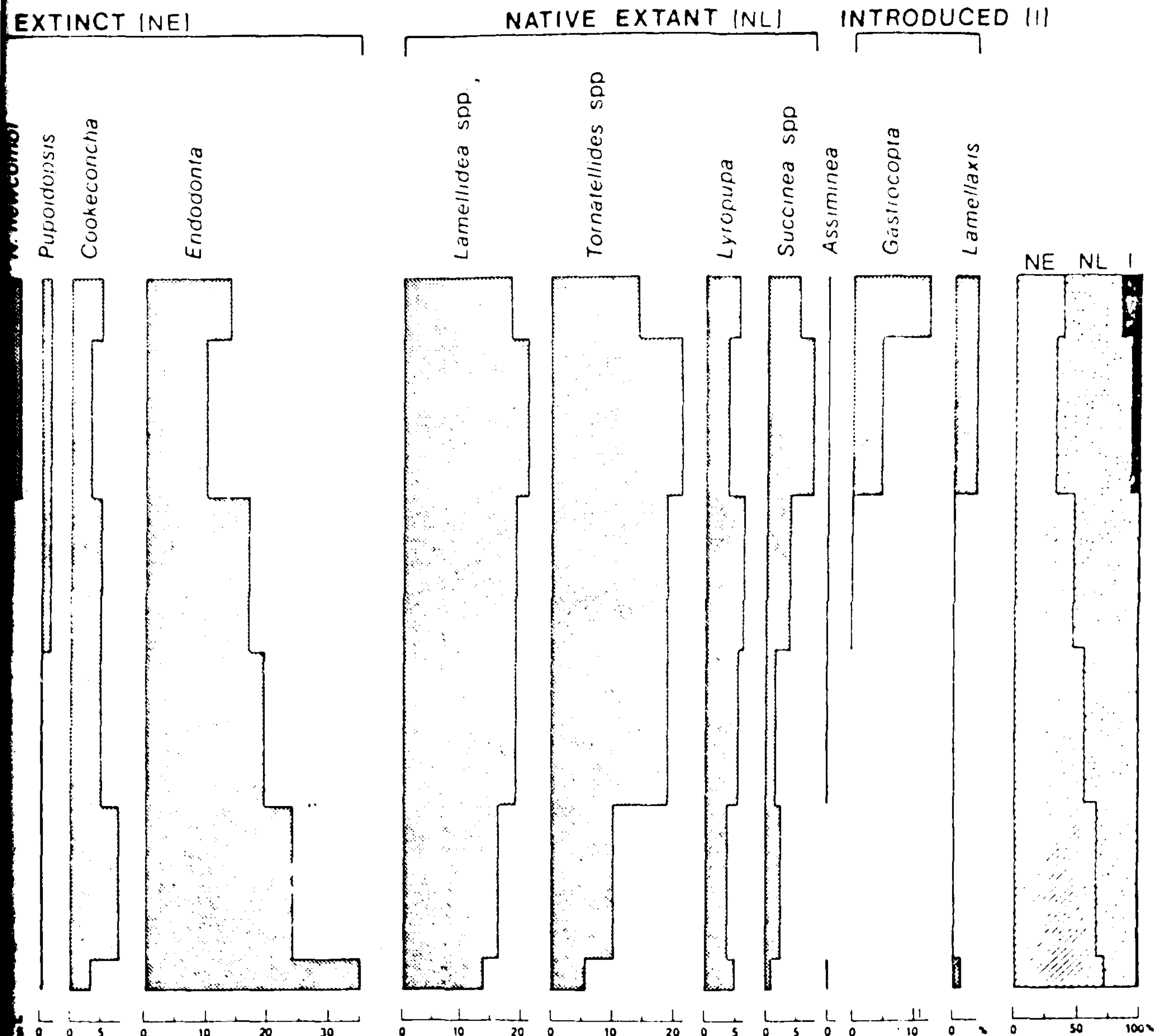


FIGURE 4 LANDSNAIL DIAGRAM FOR SITE 9670-P1.



LANDSNAIL DIAGRAM FOR SITE 9670-P1.

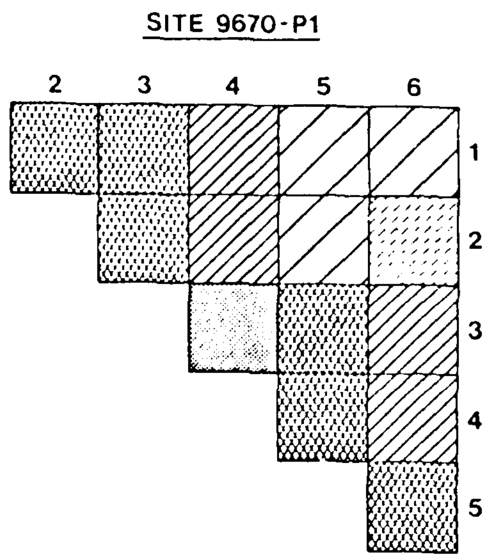


FIGURE 5 PROPORTIONAL SIMILARITY MATRIX FOR SITE 9670-P1.

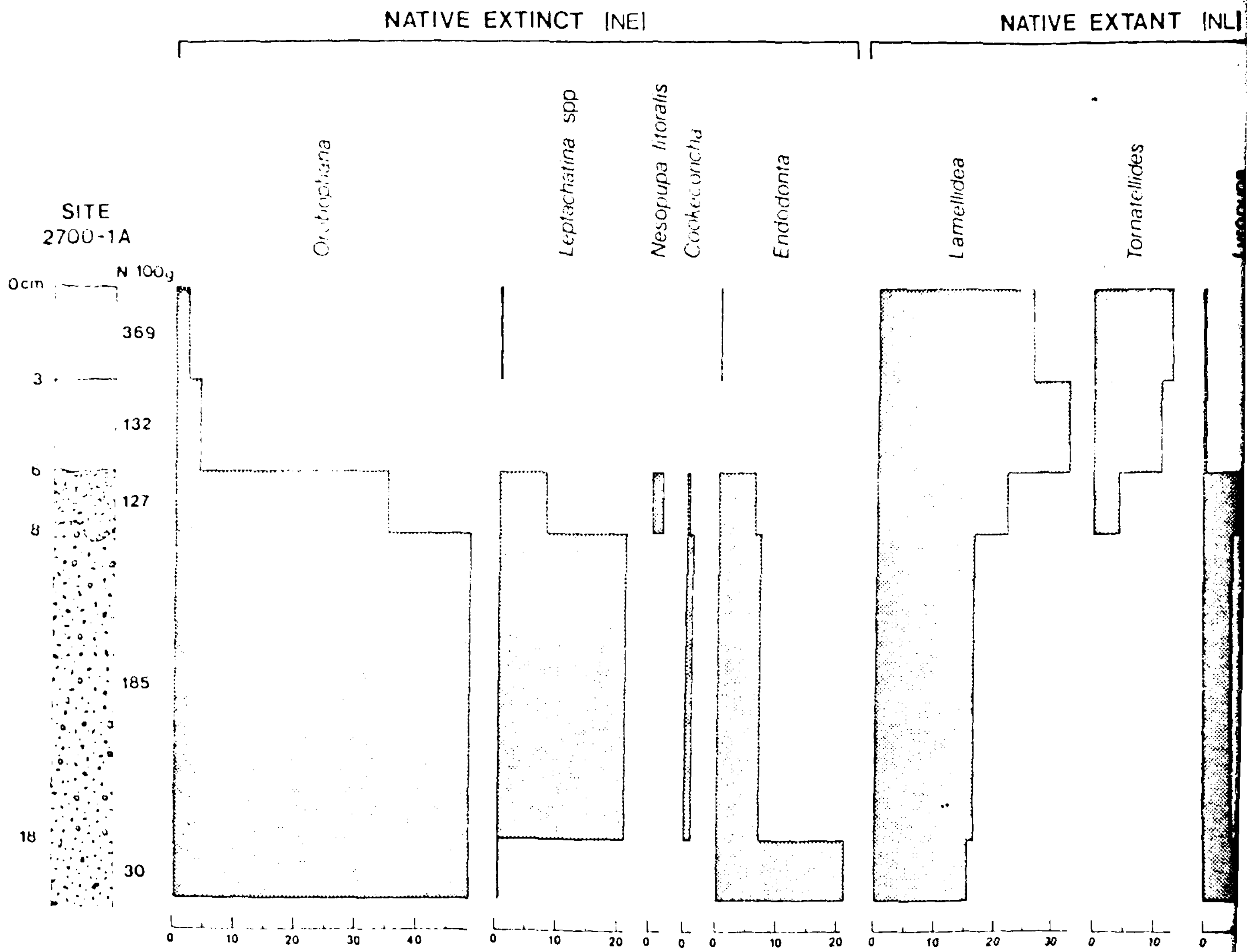
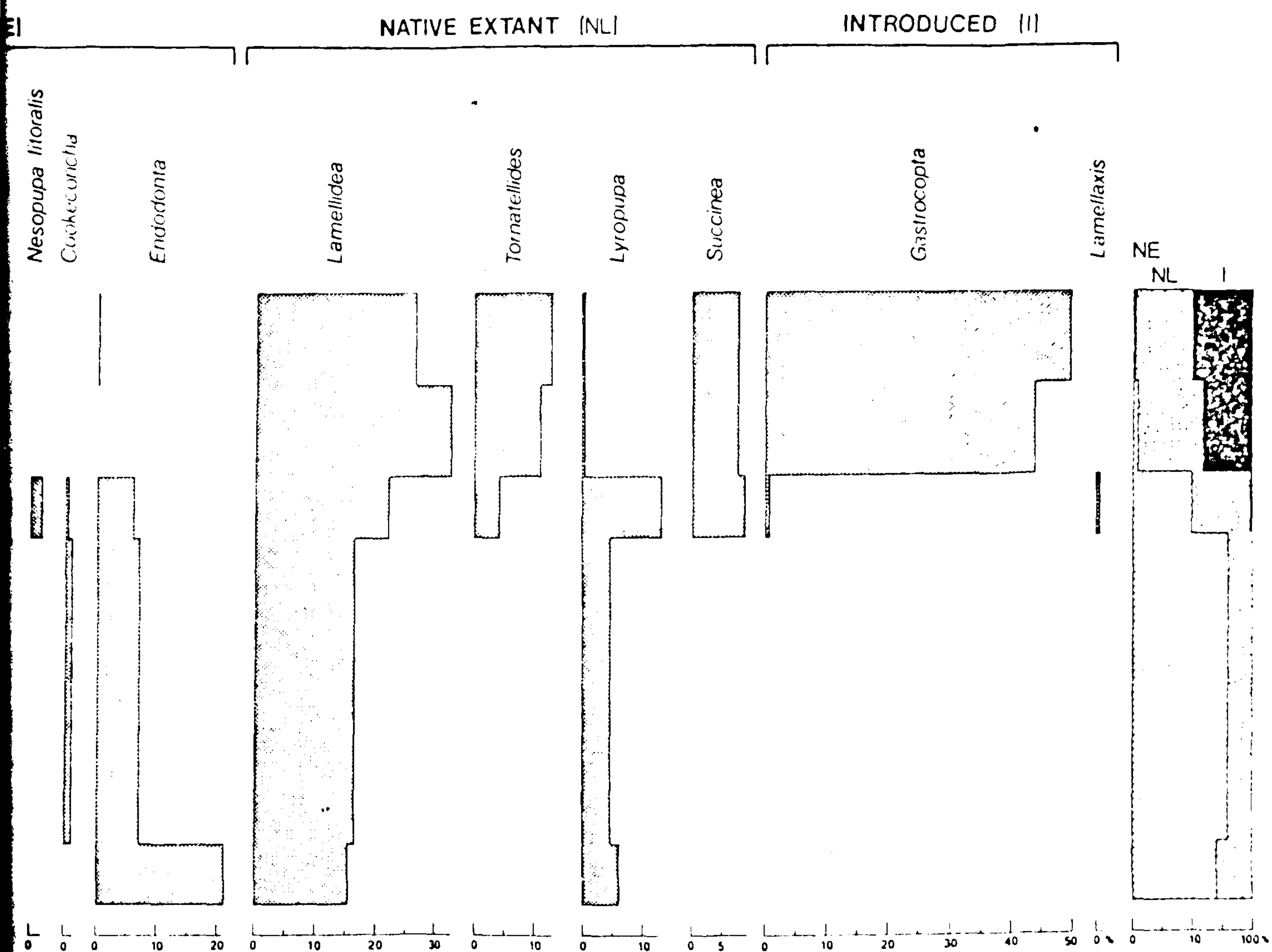


FIGURE 6 LANDSNAIL DIAGRAM FOR SITE 2700-1A.



LANDSNAIL DIAGRAM FOR SITE 2700-1A.

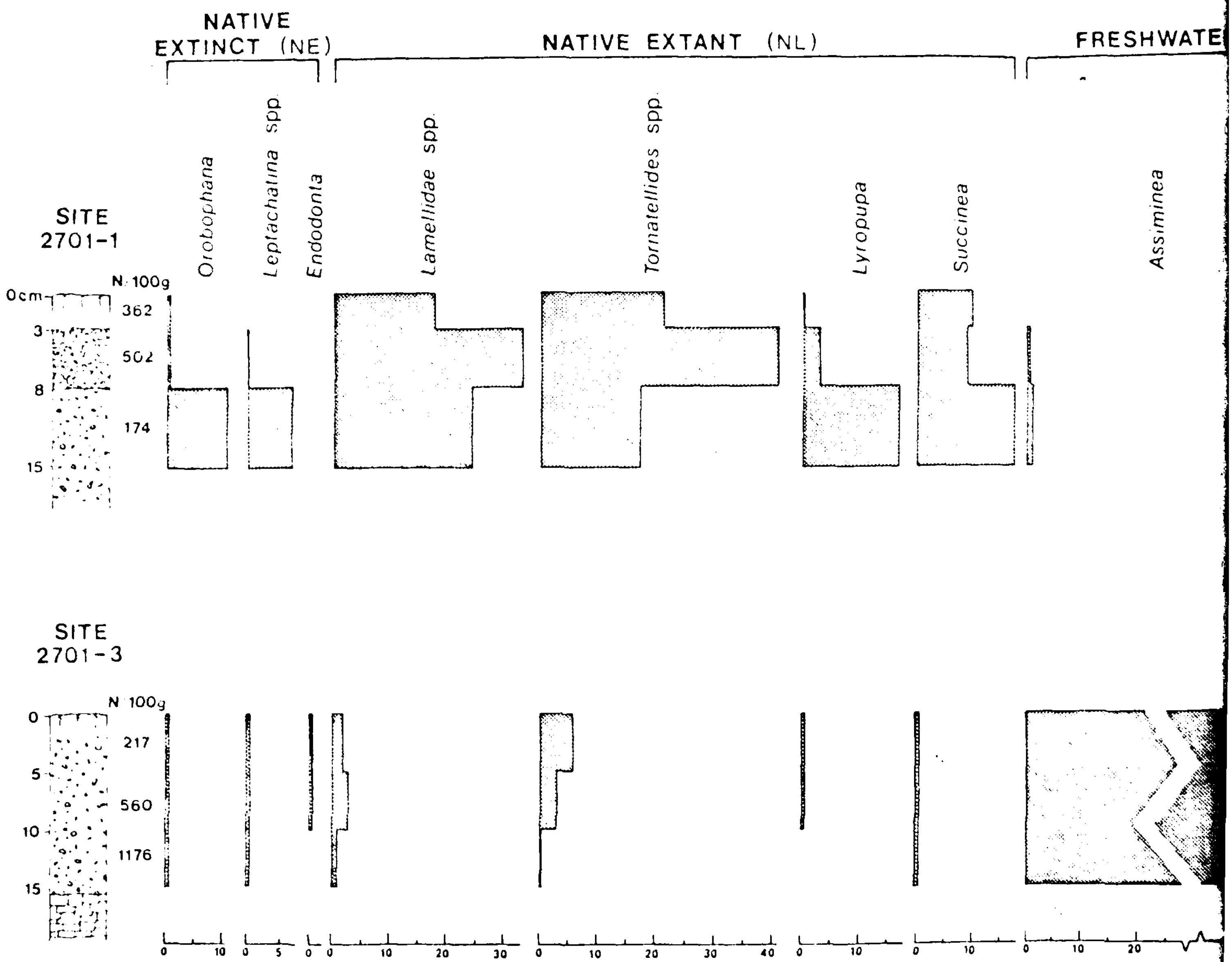
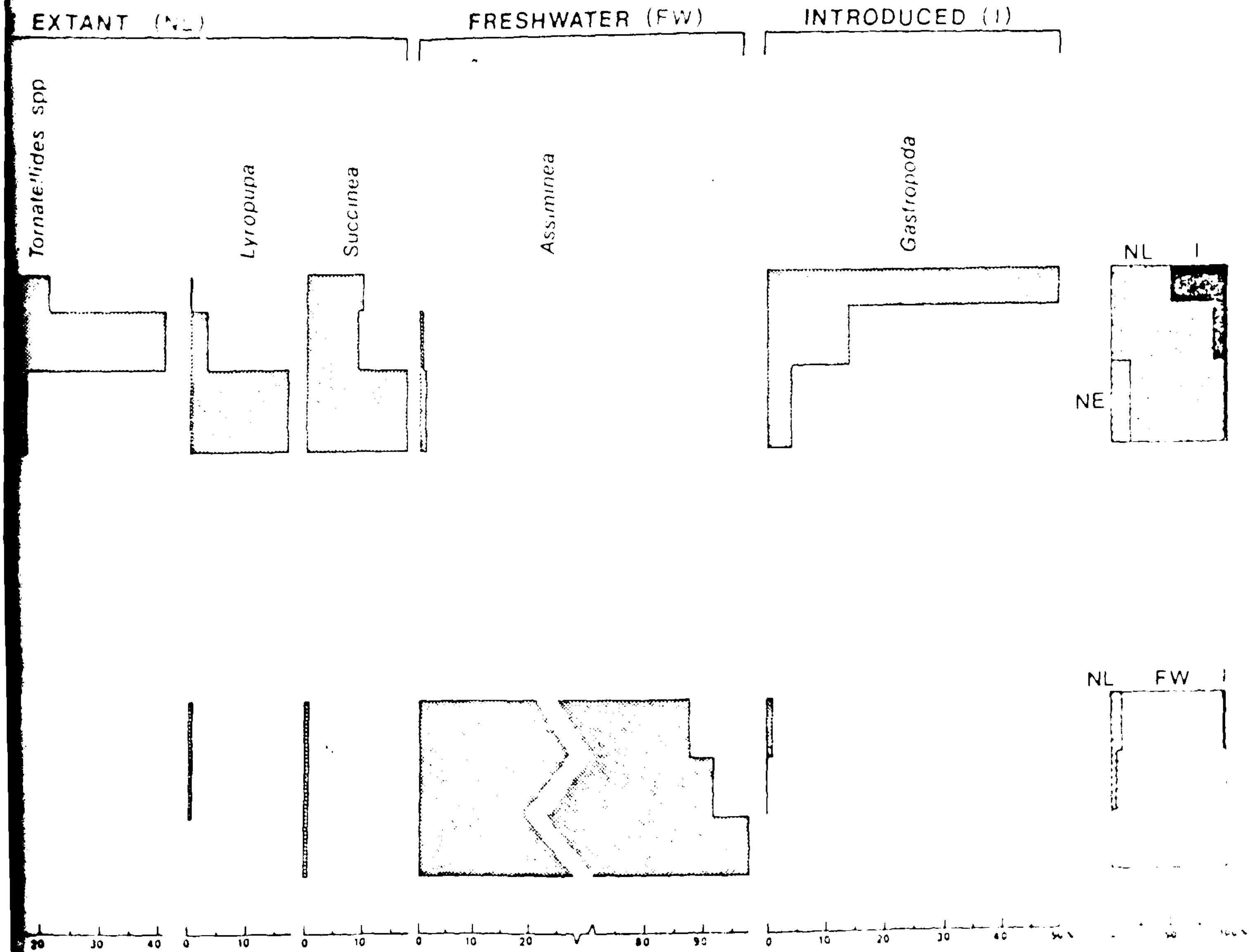


FIGURE 7 LANDSNAIL DIAGRAMS FOR SITES 2701-1 AND 2701-3.



DSNAIL DIAGRAMS FOR SITES 2701-1 AND 2701-3.

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AD-A128 230 ARCHAEOLOGICAL AND PALEONTOLOGICAL INVESTIGATION AT KALAELOA (BARBER'S PO..(U) ARCHAEOLOGICAL RESEARCH CENTER HAWAII INC H H HAMMATT ET AL. JUL 81

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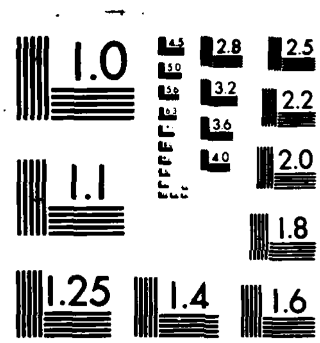

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

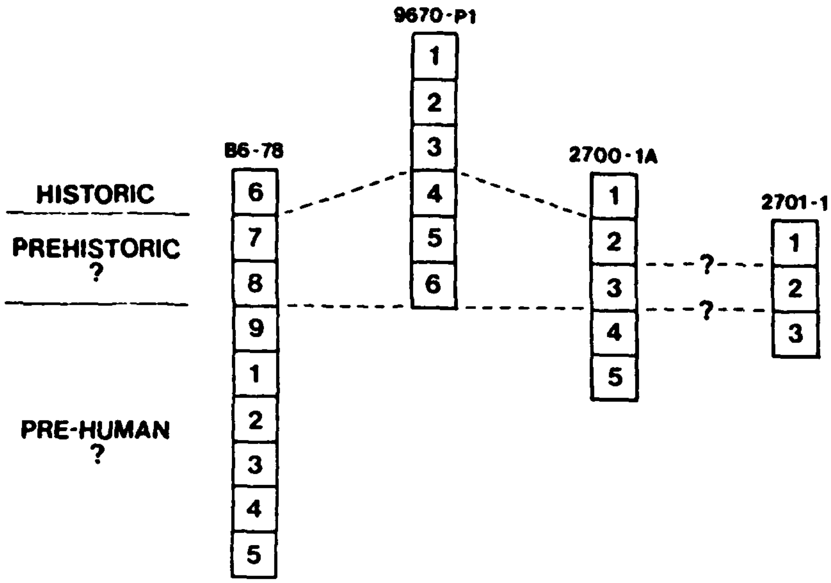

Fig. 8. TENTATIVE CORRELATIONS BETWEEN BARBER'S POINT STRATIGRAPHIC COLUMNS.

Received by D. Sox
on 20 Oct 81

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19 October 1981

Mr. Kisuk Cheung
Chief, Engineering Division
US Army Corps of Engineers, Pacific Ocean Division
Building 230
Fort Shafter, Hawaii 96858

SUBJECT: Review of Archaeological Research Center Hawaii (ARCH) Report:

Archaeological and Paleontological Investigation at Kalaeloa (Barber's Point), Hono'uli'uli. 'Ewa, O'ahu--Federal Study Areas 1a and 1b, State of Hawaii Optional Area 1 --FINAL DRAFT--

Dear Mr. Cheung:

Comment regarding the above named document is being submitted as per your letter of transmittal (no date) received 23 September 1981.

This is the third review of the ARCH salvage program I have undertaken since it was proposed in 1979 and I must confess that after several readings, despite the completion of sections missing from the initial review draft, I find little substantive improvement in the "final draft." Indeed, the additional information now provided makes many of the theoretical and methodological weaknesses all the more apparent.

I have consistently expressed concern regarding the lak of an explicitly stated sampling strategy for data recovery, and the lack of criteria for determining the adequacy of the data recovered to address stated research goals. These have been; in my opinion, critical problem areas since the inception of the salvage program and have unnecessarily flawed the final results. No amount of cosmetic editorial work or additional laboratory analysis, except perhaps in alternative dating techniques, can resolve these deficiencies after-the-fact. In as much as the present document remains essentially unchanged from previous drafts, I see little reason to justify another lengthy and detailed review. My earlier comments are therefore appended.

In the long run this is a most unfortunate circumstance since a number of parties have expended considerable effort to assure that the enormous potential of the Barbers Point area be successfully realized. Yet, in its present form, the "final" ARCH report must be considered inadequate for the purposes of mitigating adverse impact and unreliable as a potential resource document to guide further scientific research in the Ewa region.

Sincerely,

Bertell D. Davis

Bertell D. Davis

University of Hawaii at Manoa

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11 March 1981

Mr. Kisuk Cheung
Chief, Engineering Division
U.S. Army Corps of Engineers, Pacific Ocean Division
Building 230
Fort Shafter, Hawaii 96858

SUBJECT: Review of Archaeological Research Center Hawaii (ARCH) Report: Archaeological and Paleontological Investigation at Kalaeloa (Barber's Point), Hono'uli'uli, 'Ewa, O'ahu -- Federal Study Areas 1a and 1b, and State of Hawaii Optional Area 1

Dear Mr. Cheung:

The following is a review of the ARCH report submitted to the U.S. Army Corps of Engineers, Pacific Ocean Division, on archaeological and palaeontological salvage excavations conducted in the Federal Areas 1a and 1b and the State of Hawaii Optional Area 1 at Barbers Point, Oahu. The report and pertinent reference documents were received in mid-February, but many of the figures and tables were incomplete. Although the letter of transmittal noted that the missing material would be forwarded as soon as available, these have not arrived. For this reason, and for other apparent instances of omission or incomplete information, the report in its present form cannot be considered adequate for review as other than a draft manuscript. This review is therefore only a preliminary evaluation of the salvage report; a more thoroughgoing review should be made when the entire document has been completed.

To begin with, because of my own research interest in the Barbers Point area, in March of 1980, after ARCH had begun fieldwork, I requested copies of the ARCH revised research designs for the Federal and State Areas from the State Historic Preservation Office (SHPO). Except for site-specific details, the two documents were essentially the same.

Although the overall archaeological significance of the Barbers Point area and the strategy for realizing that significance seemed generally well set forth by the research designs, there were a number of significant points which were treated in a less than satisfying manner. Specifically, the problem areas were: (a) lack of an explicitly stated sampling design for data recovery, (b) lack of criteria for determining adequacy of the data recovered to address stated research goals, and (c) estimated project time by which to attain those goals. Using the research design for the Federal portion of the project area as a basis for comment, I therefore submitted an unsolicited review to the SHPO (that review is attached for your reference).

In reading over the "draft" salvage report I can only surmise that the deficiencies addressed in the previous review have indeed seriously affected the research results at Barbers Point. The attached review of the research design will therefore serve as the major portion of my comments regarding the "draft" report. However, there are several issues I wish to emphasize further.

1. Sampling Procedures and Strategy.

The "draft" report notes that in addition to a statement of the research problems the research design included "a statement of data requirements; a sampling strategy to collect adequate data to test the hypotheses" (page 7). I do not find this to be the case. Nor was this true for the revised research designs, as stated in my previous review. Nowhere in the current document or in the background material is the sampling strategy or the criteria for determining the adequacy of the recovered data set explicitly defined. This is a most important issue since the function of a sampling frame is to allow the researcher to arrive at reasoned conclusions based on controlled quantification of the data. Where the sampling design is not made explicit, subsequent conclusions are likely to rest solely upon assumption and intuition. For example, consider how the midden and other small remains were collected as stated in the "draft" report.

> Shell, bone, midden, and other residue were screened from the matrix with a 100% sample collected from the 1 4-inch screen (page 10)...all material retained by the 1 8-inch screen was discarded after field checking to isolate shell species or other materials not represented in the midden from the 1 4-inch screen and to recover artifactual material (page 169).

As early as March-April of 1979, ARCH was appraised of potential problems regarding the extent and the rather small size of the material content of the cultural deposits at Barbers Point. This was in fact noted in the revised research design by reference to my personal communication. Although at that time I had not yet quantified the potential loss of material through 1 4-inch screens, it was estimated to be possibly as much as 30% of the total midden with even higher loss rates for potentially important food resources subject to greater breakage, such as fish bone or the Brachidontes mussel shell.

That the kind of sampling frame employed can yield different information from the same excavation is clearly recognized in the "draft" report by the following:

> The preliminary evaluation of artifact and midden assemblages and densities found during the testing focused excavation on sites with defined manufacturing and subsistence activity areas...Considering the effects of various types of sampling strategies on the types or intensities of field and laboratory analytical techniques, the emphasis was placed on establishing inter- and intra-feature chronology and on defining distinct activity areas to the maximum extent of their horizontal spread (page 11; emphasis mine).

In my experience at Barbers Point, the volcanic glass is the class of material which potentially suffers the greatest loss when using 1 4-inch screens and not retaining the 1 8-inch material for laboratory analysis. In one site I excavated, for which analysis is now complete, $15m^2$ averaging 5-10cm deep yielded in excess of 900 pieces of volcanic glass. Of this, an estimated 75% would have been lost through the 1 4-inch screen. And adjacent to the State Optional Area, the B6-58 site excavated by Aki Sinoto of the Bishop Museum yielded 107 pieces of volcanic glass from approximately $7m^2$ (1976; Cultural Resources Survey Report). It is certainly true, however, that there are sites at Barbers Point which yield no glass, but these are apparently very task-specific structures and not "ordinary" or multi-purpose habitation sites. In contrast, more than $130m^2$ (the information in the "draft" report is incomplete on this point) were excavated at 14 surface habitation sites in the Federal and State Areas, yet this yielded only 55 pieces of volcanic glass. It seems very likely that the low recovery rate for volcanic glass expressed in the "draft" report is more the result of field technique rather than solely the absence of this material in the sites.

2. Effects of Sampling on Functional and Temporal Interpretations.

The above situation is most unfortunate since so much of the salvage work emphasized deliniating activity areas (and therefrom probable site functions) and developing a firm chronology for human settlement at Barbers Point. Thus the midden in general and the volcanic glass in particular were important to several of the major hypotheses set out in the research design.

> In the prehistoric period, intensity of occupation as well as specialization of function of certain features are related to the size of the features and size and density of the features clusterings.
>
> The larger residence units show greater specialization of function of each feature within the unit and greater intensity of occupation than the smaller units.
>
> There is differentiation of site-feature function with all occupation features showing evidence of food preparation and consumption but only features within larger site clusters showing evidence of manufacturing activities.
> Specific food preparation and cooking activity areas can be discerned in the archaeological record and the dominant subsistence indicated by these areas is based on marine resources, and increasingly on terrestrial resources over time.
>
> Manufacturing activity areas consisting of working of stone, bone, and shell materials is definable (sic) can be defined in the archaeological record and occurs in association with the food-preparation and cooking areas. Manufacturing activities emphasizes marine subsistence and terrestrial resources increasingly over time (pages 8-9; emphasis mine).

Clearly, intensity of occupation, specialization of function, greater intensity or specialization, and so on are all relative terms. Determining that one site was more or less intensively utilized than another requires rigorous quantification of various data sets from all the features being so compared. But if the midden and other refuse are collected in such a way that distorts the qualitative and quantitative content of these residues, then any results derived from analyzing the skewed data set are spurious. As for deliniating activity areas, potential skewness is an equally serious problem. Although the presence of non-portable features such as hearths may indicate the location of possible cooking areas, defining manufacturing areas requires that certain materials occur in demonstrable quantities greater in some sites (or portions of larger site deposits) than in others. Example: the presence of volcanic glass from seemingly random locations within the overall site does not necessarily indicate that glass flaking was a significant activity at that site. But finding quantities of small waste flakes throughout the site would suggest that all or most of the site may have been a glass workshop, whereas finding these waste flakes concentrated within a limited area of the site would suggest that only a portion of the site was used as a workshop with other portions of the site likely serving other functions. This example is rather abbreviated, but the point is that if upwards to three-quarters of the volcanic glass in a potential workshop is lost through improper collecting techniques, such patterns may be obscured or lost entirely.

3. Adequacy of Conclusions Regarding Function.

Given the above discussion, the generalized conclusion offered in the "draft" report that the Barbers Point sites are similar to other typical prehistoric occupation areas (page 19) is unfounded. I feel this is so for two additional reasons. First, just what consitutes "typical...small occupation sites of common status peoples found in many coastal areas throughout the main Hawaiian Islands" (page 20) is never stated. Secondly, referring back to the statement that "preliminary evaluation of artifact and midden assemblages and densities found during the testing focused excavation on sites with defined manufacturing and subsistence activity areas" (page 11; emphasis mine) suggests to me that habitation sites which did not express such activity areas were not investigated during the salvage portion of the project. (I will return to this point in section 5 below). In reviewing the research design (see attachment, page 4; item 2) I addressed a similar problem regarding omission of potentially important sites from the salvage phase because the sites did not demonstrate the desired time range of occupation. To thus limit the investigation of the Barbers Point sites to a few select feature types will not yield the broader range of data necessary to determine the overall pattern of aboriginal settlement in the region.

4. Adequacy of Conclusions Regarding Chronology.

Returning to the "draft" report's emphasis on developing a firm chronology for human settlement at Barbers Point, it was hypothesized that:

> The spacial-temporal pattern in the occupation is represented by initial occupation of smaller, more isolated residence sites, followed by a shift to the larger, more tightly clustered residence complexes, and then a reversal of the trend in the post-European contact period (page 8).

On the basis of the data recovered, the authors were forced to conclude that this hypothesis "proved untestable due to the paucity of datable material in a large number of the sites and to the contemporaneity of the dated samples" (page 15). The results are similarly inconclusive regarding the hypothesis that terrestrial subsistence resources increased in importance over marine resources through time.

Clearly the probable loss of volcanic glass as discussed above may well account for the "paucity of datable material". However, the above statement, among others, suggests to me a more pervasive weakness in the "draft" report: an apparent lack of due consideration for alternative hypotheses. If the dated samples are contemporaneous and are also from different sites (this cannot be determined from the present report), this and other lines of evidence may indicate that there was little or no shift in the basic settlement pattern over the apparently short period of human occupation of Barbers Point. In either respect, a line of scientific inquiry must be demonstrated to be unprofitable before it is finally abandoned, and this must be done rigorously--not by assumption or facile judgements.

5. Assumptions Regarding Adequacy of Test Results for Selecting Sites to be Salvaged.

As an example of how unstated assumptions can adversely affect subsequent research results, consider the following.

> These test excavations made possible evaluation of <u>artifact content and density</u>, <u>midden content and density</u>, depth and <u>lateral extent of cultural deposits</u> (in square meters), and potential subsistence and manufacturing activities and <u>activity areas within and around features</u> (page 10; emphasis mine).

In reviewing the research design I noted that such testing would provide a solid foundation for subsequent salvage excavations, but only by employing a well planned strategy for collecting pertinent test data in the field and only if <u>all</u> the test data were analyzed prior to excavation (see attachment, page 6). How these test data were analyzed to justify the above statement is not known; this is not discussed in the "draft" report nor in the two letter reports sumitted following the close of the testing phase of the project (letters dated 26 March and 4 April 1980 for the Federal and State Areas, respectively). The letter do, however, indicate that these tests were excavated pit ranging from 1 x 1m down to 25 x 25cm in size. In-field observation noted that the latter was the most frequent size. The point is that one or two test pits measuring only 25 x 25cm <u>does not</u> reveal the lateral extent of cultural deposits which may range from only $10m^2$ to $120m^2$ or more--the possibility of which ARCH had been appraised in 1979. Indeed, although the "draft" report generally indicates the area of excavation in most of the sites, nowhere in the report could I find any information as to the total estimated areas of the various deposits.

If the total area of a given deposit cannot be estimated, then it follows that artifact and midden densities cannot be determined nor can potential activity areas be evaluated. If so, then it seems to me that to focus salvage excavations on only those sites with "defined manufacturing and subsistence activity areas" (page 11) as determined from the test data is to in effect make decisions based on assumption and false evidence. The net result is that only 14 of the 46 potential habitation structures in the project area were excavated. Little or no reliable information is resently available from the remaining 32 features.

In sum, the "draft" report states that "the contractor has recovered and preserved an adequate sample of paleontological, scientific, prehistorical and historical archaeological data for analysis and interpretation of the cultural and environmental conditions prevailing during the period of human occupation" (page 5). Regarding the appended reports by Olson on the avian palaeontology, by Kirch and Christensen on the terrestrial mollusks, and by Albert on the military history of Barbers Point, the contractor's claim may be appropriate. But as for the archaeological report, for the reasons presented in this and in the attached review, I can only disagree.

Respectfully,

Bertell D. Davis
Archaeologist

NOTE: REVIEW of REVISED ARCH PROPOSAL (12 OCTOBER 1979) for FEDERAL STOCKPILE AREA

24 March 1980

TO: Patricia Beggerly, Archaeologist
State Historic Preservation Office
Department of Land and Natural Resources
State of Hawaii

FROM: Bertell D. Davis, Archaeologist
Department of Anthropology
University of Hawaii-Manoa

SUBJECT: Review of Archaeological Research Center Hawaii Proposal:
A Research Design for Cultural Resources Data Recovery at
Barbers Point Harbor, Honouliuli, Ewa, Oahu Island, Hawaii

The following is a review of the ARCH proposal submitted to the U.S. Army Corps of Engineers, Pacific Ocean Division, to conduct salvage excavation of archaeological and palaeontological resources located in the proposed Dredged Spoils Stockpile Areas 1a and 1b at Barbers Point, Oahu. This review is prepared for use by the State Historic Preservation Office, State of Hawaii.

To begin with, the research design proposed by ARCH briefly addresses the overall archaeological significance of the Barbers Point area. The general strategy for realizing that significance is also reasonably well set forth. Testing for possible evidence of aboriginal food plant cultivation seems especially well planned and, given the particular expertise of the principal investigator, this part of the proposed study should be most informative.

A number of relevant points should be considered in greater detail, however. Serious theoretical and methodological weaknesses occur in three areas: (a) the significance of the palaeontological resources apart from their possible cultural associations, (b) the nature of the sampling scheme to be employed, and (c) the estimated project time by which to attain the stated research goals. It is first of all my opinion that the proposed field-laboratory/office time ratio of approximately 1:1 is not sufficient to properly control and analyze the materials which can be expected from the excavations at Barbers Point. Secondly, the estimated time in the field is itself most unrealistic for achieving the stated research goals, given the potential extent and complexity of especially the habitation sites in the study area. And finally, my reservations regarding adequate time are based largely on the lack of clear definition of what is proposed as an adequate and appropriate sample of information from the cultural resources.

Because of the interdependence of these conditions, I will first address the proposed scheduling and the implicit sampling scheme upon which it is apparently based before discussing other concerns. A table of the tentative work schedule is appended to the proposal. Field and laboratory/office time may be broken down into man-days as follows.

Total time in the field is 390 man-days, of which: 90 are for archaeological testing; 280 for salvage excavation; and 20 for land snail and avifaunal work.

Total time in the laboratory/office is 370 man-days, of which: 205 are for archaeological analysis; 50 for land snail, avifaunal and dating analysis; and 115 for all write-up, including research of historical documents.

Clearly, 205 man-days are not sufficient to adequately treat the archaeological materials recovered by 370 man-days of testing and salvage excavation. Nor are 50 man-days adequate for the effort required in analyzing land snail and avifaunal materials recovered in 20 man-days of fieldwork if that must also be combined with dating analysis.

The proposal calls for two consecutive phases of fieldwork: test excavation and archaeological (salvage) excavation. On page 8 the proposal states that "test excavations of <u>all</u> suspected habitation features covering an area of <u>at</u> least 1 square meter..." [will be done; emphasis mine]; and again on page 9, "<u>all</u> habitation features from study area 1a and 1b were selected for testing." However, the proposed list of features to be tested (pages 9-10) includes <u>ahu</u>, rock mounds and modified sinkholes. Yet 5 habitation features (3 from Area 1a and 2 from Area 1b) are omitted without explanation. If these are added to the list, the total number of features to be tested would be 52 for a minimum of $52m^2$ excavated.

On page 13 it is estimated that 1 man-day is required to excavate $0.25m^2$. Previously excavated deposits have ranged from 5-30cm deep with an average of about 15cm. Thus, $52m^2$ would equal $7.8m^3$ requiring 31 man-days to excavate.

An estimated field time of 35 working days (210 man-days for a crew of 6) for salvage excavations is also presented in a table on page 13 (see table at end of review). The proposed sample size, or volume, to be excavated is included, but nowhere is it stated what this is based upon—although it seems that the approximate combined structural area of the features selected for the test excavation phase may have been the primary criterion. This estimated area is presented in column B of the attached table. Column D of the table then converts the proposed cubic-meter sample into square meters and percent of total area, again using the 15cm average depth.

The high sample size (149%) in Site Complex 2700 probably reflects the presence of the large habitation structure where the deposit may be expected to extend beyond the structure itself. In this and other habitation sites, "every effort will...be made to excavate total activity areas to the total extent of their horizontal spread...[for the] establishment of inter and intra feature chronology and the definition of distinct activity areas" (page 11).

However, it is then not explained why the 4 habitation features of Site Complex 2702 are to be excavated for a sample of only 70%. Nor is it explained why the 5 house sites discussed above were deleted from the test excavation phase, and presumably also from the salvage phase of fieldwork. On the other hand, the large proposed samples for Site Complexes 2704 (125%) and 2706 (133%) apparently have little to do with the single house site listed, but rather with the several ahu and modified sinkholes. If this is true, then it is difficult to explain why three rather large ahu in Site Complex 2705 were also omitted from the listed test excavations.

At first glance, the 270 man-days allowed in the tentative work schedule for archaeological testing and salvage seems most adequate in view of the approximately 240 man-days (31 for testing and 210 for salvage) extrapolated from the text of the proposal. But if the estimate time required for the deleted habitation sites and ahu are included (colu F in attached table), then an additional 42 man-days, or about 285 man-da total (column H) are needed to excavate the same proportionate sampl column G) as proposed. The most important point here is that this is estim d time for the archae- ology only; there are no specific references to sch ing for the palaeon- tology beyond the tentative schedule appended to th posal. The palaeon- tological and land snail work are allowed only 20 man-days total in the field. Given the complexities expected of trying to stratigraphically relate the extinct avifauna to the cultural deposits, 20 days for the palaeontologist himself seems hardly sufficient. Unless time is sacrificed from other tasks, the palaeontology will come up short. But even if the time is sacrificed, from whatever task, the project as a whole still lacks the time to meet its proposed goals.

This is a very important point, since whatever criteria the proposed estimates were based upon, they clearly fail to take new data into account regarding the potential extent of the habitation deposits. That ARCH was aware that the cultural deposits were far exceeding the structural areas of the sites is indicated by the reference to Davis' personal communication-- which included this information in addition to the location of the hearths and possible activity areas.

The recent excavations on which the communication was based showed that the cultural depoists ranged from $0m^2$ in sites which proved sterile to as much as 6.5 times the structural area of the site. Comparing the total structural area of these house sites ($118m^2$) with the total estimated area of the associated deposits (ca. $290m^2$) gives a structure to deposit ratio of about 1:2.5. If we use the conservative figure of 1:2 and apply it to the structural area of the habitation sites listed in the ARCH proposal (and to the features omitted), we get new areal figures for the site complexes to be excavated (column I in the table) from which to estimate new sample sizes (it should be noted that the percent-sample for Complexes 2700, 2704 and 2706 must be reduced to 100% since we are now using deposit and not struc- tural area) and field time required (columns J and K). This yields a required time of about 450 man-days of archaeological excavation to fulfill the stated research goals in the manner proposed. Moreover, even allowing that the $52m^2$ of test excavation are included in this final sample, the total estimated project time, including laboratory and office time at the inadequate ratio of 1:1, would be 450 + 20 (not adjusting any time for the palaeontology and land snails) + 470 (laboratory and office) totalling 940 man-days, or nearly 200 man-days more than proposed!

Time estimates are of course based on the amount of work proposed, the data sample required to effectively attain stated research goals, and how that work is to be conducted. This is one purpose for developing a research design. Page 2 of the proposal states that

> The purpose of this research design is to detail the general goals of the research, and the methods of data recovery and analysis required to salvage an adequate and appropriate sample of information from the cultural resources...(emphasis mine).

The general research goals are in fact rather well stated by the proposal. But just what constitutes an adequate and appropriate sample is not discussed, and the resulting problems in estimating project time are apparent as discussed above. Indeed, the statement on page 11 that "the preliminary chronology developed during testing will permit the design of a sampling strategy..." indicates that the research design itself is incomplete and that the adequate and appropriate sample has not been defined.

The problem is two-fold. First, neither the customer nor the reviewer can confidently determine the relationship between the proposed work and the estimated time to do that work, and ultimately (for the customer at least) the cost. Secondly, for the archaeologist himself not to have clearly defined at least a preliminary framework to sample what and how much for what ends leaves him without planned control over the progress of the work. One simply does not recognize whether the expected data or new and potentially significant data are forthcoming without some basis of comparison. Thus, the sampling design is a tool for planning ahead as well as for evaluating results, and as such it should be defined and implemented from the start. If modifications become necessary as work progresses, the archaeologist will then be in a position to control for it.

That some advance thought has been given to sampling is evident in the proposal. But it seems to me that this is largely implicit, unorganized and possibly contradictory. Consider the following statements (some already mentioned above).

1. It was twice stated that test excavations would be conducted in all habitation sites in Areas 1a and 1b (pages 8-9).

However, 5 habitation features were omitted without explanation from the list of specific features to be tested. If, as discussed below, the purpose of the tests is to identify particular sites for later salvage excavation, then these 5 sites would be omitted from the study completely and no data would be had from them beyond that from the survey. Given the significant data recovered from the recent excavations in similar sites at Barbers Point, this represents a potentially serious loss of information--especially for determining chronological relationships.

2. The test excavation phase is intended to "permit the design of a sampling strategy in which sites and features of different ages

are excavated for the purpose of developing a diachronic sequence for settlement patterns...archaeologically expressed cultural variability through time. Therefore, features which reflect the greatest time range both internally and externally will be selected" (page 11).

This in itself is a reasonable strategy for obtaining relevant settlement data. It is also clearly a sampling frame in which the first echelon of the sample is composed of sites selected among sites. But habitation features which fall into this category could be among the 5 for which no testing in proposed. Moreover, what is the greatest internal and external time range, and what does this mean in terms of the overall period of aboriginal settlement which is so far dated at about A.D. 1600-1870? Suppose a number of task-specific features exhibit contemporaneous but relatively short duration of use--are these to be ignored because they do not reflect the greatest time range? If so, this seems to contradict the purpose of the sampling scheme for excavating sites and features of different ages.

3. "Every effort will...be made to excavate total activity areas to the total extent of their horizontal spread.../for the/ establishment of inter and intra feature chronology and the definition of distinct activity areas" (page 11).

I agree that control of inter and intra feature chronology is critical in determining the nature of the aboriginal settlement and how it may have changed through the prehistoric and early historic periods. But I am uncertain as to what is meant by "total activity areas". In my experience at Barbers Point, this could be virtually the entire cultural deposit associated with each house site, particularly since these deposits have not yet proven to be continuous from one house site to another. If this is what is meant by total activity areas, then certainly there is not enough time allowed in the proposal for such excavation, especially since it is not determined (or at least not stated) how many sites are finally to be excavated. Indeed, one gets the feeling that an ill-planned time schedule may ultimately become the critical factor in the final sampling design. However, even if time were available, I question whether such an approach would be profitable for the research. Would it not be more efficient to systematically sample (note that I do not mean merely a few test squares) all the habitation sites to answer specific questions (especially inter feature), and then do total excavation of several sites selected to answer other questions (especially intra feature) derived, or more clearly deliniated, from the initial sampling phase? Granted that this may seem to be what is proposed by ARCH, but it is a methodologically more rigorous approach.

If, on the other hand, total activity areas are meant to be only the hearths and the presumably associated volcanic glass core and flake remains referenced in the background section of the proposal, then I must ask what of the rest of the deposit in this site or that site? By focusing exclusively on one aspect of the house sites at Barbers Point we will come to know a great deal about that aspect. But we will know little or nothing about other aspects equally important to understanding especially the nature of the local residence groups--whether these be single or multiple households, or some other social unit.

4. "Shell, bone, and other residue will be screened from the matrix with a 100% sample collected..." (page 8, 11).

Again the research design is incomplete since the field methods are not further elaborated. What is meant here by a 100% sample collected? If it is intended to mean that all midden in the excavated squares will be collected, then this obviously is in error since some of that midden will be lost through the screen. The only 100% sample possible is of all midden remaining in the screen. But other questions arise. Will the midden be sorted from the screens in the field, or will all screened material be processed in the laboratory? The latter is the only way to assure complete collection. Also, what mesh size will be used, and will control units be excavated to determine the probable rate of material lost by screening? This is most critical, since the recent work at Barbers Point has shown, for example, that 60-80% of the volcanic glass artifacts may be lost by using 1/4-inch mesh screens—a loss which could serious affect inferences regarding activity areas.

5. And finally, regarding the sampling problem, "food residues (midden) analysis, including sorting of components, species identification, weighing and calculations of weight percent, and concentration indicies will be done. Samples will be selected and analyzed in this way to document spacial and temporal patterns of residue disposal and subsistence" (page 14).

Accepting that, with the appropriate field methods, these residues will be collected so other more detailed analyses may be carried out by interested researchers at a later date, the proposed analysis seems most adequate for providing an initial interpretive foundation. If done rigorously, this will also suffice for the purposes of the contract and for fulfilling responsibilities of historic preservation. But I can only infer from the concluding sentence that the analysis will use only what amounts to samples of samples. While this may be an appropriate strategy for analyzing midden from features selected for large-scale excavation, what of the other sites in which only a small portion of the cultural deposits are excavated? Again it is not stated how much or from which possible sites these samples will be selected.

Beyond the scheduling and sampling problems discussed thus far, I must comment on what I see as a number of procedural assumptions relating the test excavation phase of the project with the archaeological salvage phase. First of all,

> "As a result of the test excavations [in the suspected habitation sites] it will be possible to evaluate artifact content and density, midden composition and density, depth and lateral extent of cultural deposits in square meters, and potential subsistence and manufacturing activities and activity areas within and around features...and on the basis of the results it will be possible to grasp the major elements of the research universe" (page 8).

What is proposed here would indeed provide a solid foundation for the major phase of salvage excavations. To accomplish this, however, would clearly require not only a well planned strategy for collecting pertinent test data in the field, but also that all the test data be analyzed in detail before the subsequent phase of research be undertaken.

As already mentioned, this preliminary analysis will include age determination of the volcanic glass for developing a chronology which will be the basis of the sampling design. There are only two laboratories in the state for glass analysis. The volume of work which both are now handling is such that some delay in receiving the results of the analysis must be expected, especially since glass may be recovered from all 33 suspected habitation sites and that perhaps 5-10 samples from each site may be required to assure dating of the approximate duration of occupation. This rather high initial sample is suugested from experience in which all 5 initial glass samples from two recently excavated sites each proved opaque in thin-section, and thus not datable.

Because of the two-phase organization of the proposed project with its heavy emphasis on the analysis of the test data as the foundation for developing the ultimate design of the archaeological salvage, I most strongly recommend that an interim progress report be prepared for review by both the U.S. Army Engineer's Environmental Section and the State Historic Preservation Office. Such a report could be quite preliminary, but it should thoroughly discuss the test data and the sampling design derived from that data to assure that expected research goals will be reasonably well met.

Up to this point I have focused only on the cultural resources, and indeed the proposal itself focuses primarily upon the archaeology. On page 2 the proposal states that

> "...19 separate sinkholes [are recommended by the Bishop Museum] for paleontological salvage. We feel that paleontological research on such a scale is unnecessary <u>at this stage</u> <u>as the main focus</u> of the paleontological work is on human avifaunal relationships" (emphasis mine).

First of all, let us not forget that a good part of the significance of the Barbers Point area rests on the extinct bird remains in addition to the cultural resources, and that resources which have demonstrated significant value for natural history are equally important in the view of the National Register as are the cultural resources. And secondly, once this work is completed the archaeologist has in effect said that no further work is necessary in Areas 1a and 1b. I must therefore ask at what stage will palaeontological research at the scale recommended by the Museum be necessary? If it is unnecessary in Areas 1a and 1b, then will it be appropriate in the State's shore-side facilities area, or in alternative stockpile areas, or will it be only once these resources are lost and it is too late? In my opinion, this proposition is totally <u>unacceptable</u> without some clear explanation as to why further work is unnecessary.

Indeed, if the Museum's recommendations go beyond the perceived goals of the proposed research, then why call for additional testing for palaeontological remains?

> "In addition five to six unmodified sinkholes will be tested in order to evaluate paleontological potential..."(page 9).

The Museum tested a total of 24 sinkholes in Area 1b located within quadrats selected by a systematic stratified sampling frame. Bird remains were found in 19 sinkholes, or 80% of the test sample, and 3 of these also yielded extinct bird remains. It is very likely, based on past experience, that more extinct avifaunal material will be found upon closer examination of the material from the other sinks. The additional testing may be proposed for Area 1a for which there is little preliminary information, but this is not stated to be the case.

In sum, I do not find this proposal adequate or appropriate for the research that is required by the archaeological and palaeontological resources at Barbers Point. Although the general research goals are well stated for the archaeology, they are too limited with respect to the extinct avifauna. Both the field and laboratory methods understated, and the sampling design itself seems largely undefined. Thus, it is most difficult to evaluate the proposed time schedule with any degree of confidence. If unchanged, in the long run these deficiencies can only hinder the successful completion of what should be rightfully significant research into one sector of Hawaii's prehistory.

Estimates on extent of habitation deposits based on excavations in Survey Zone II (see Davis and Griffin 1978, Eds. Barbers Point Archaeological Survey).

Site/ Feature	Structural Area	Estimated Deposit	Deposit Area as % of Structure Area
2714-2 (C-shape)	15m^2	Sterile	0
2714-3 (C-shape)	9	Sterile	0
2714-4 (C-shape)	7	Sterile	0
2714-5 (C-shape)	10	65m^2	650 %
2716-2 (Enclosure)	25	125	500 %
2716-3 (Enclosure)	17	17	100 %
2716-4 (Enclosure)	15	20	133 %
2716-5 (C-shape)	20	25	125 %
2716-6 (C-shape)	6	40	666 %
	118m^2	292m^2	

Ratio of Structural Area to Estimated Deposit: 1:2.47m^2

A	B	C	D	E	F	G	H	I	J	K
Site Complex	Struct Area	Propose Sample	Sample by Area / %	Propose Field Time	Adjust Area	Adjust Sample	Adjust Field Time	Total Area	Total Sample	Total Field Time
2700	$67m^2$	$15m^3$	100 / 149	10 days	$67m^2$	$15m^3$	10 days	$120m^2$	$18m^3$	12 days
2701	30	3	20 / 67	2	30	3	2	48	5	3
2702	43	4.5	30 / 70	3	43	4.5	3	86	9	6
2704	8	1.5	10 / 125	1	8	1.5	1	13	2	2
2705	48	3	20 / 42	2	56	4	3	79	5	3
2706	15	3	20 / 133	2	47	9	6	95	14	10
2707	135	7.5	50 / 37	5	135	7.5	5	135	7.5	5
9646-9694	123	15	100 / 81	10	145	18	12	422	51	34
				35 working days			42 working days			75 working days

Estimated rate of excavation is $0.25m^3$ per man-day, and using a 6-man crew

Therefore: 35 working days -- 210 man-days
42 working days -- 252 man-days
75 working days -- 450 man-days

B I S H O P M U S E U M

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Anthropology Department

6 October 1981

Mr. Kisuk Cheung
Chief, Engineering Division
Department of the Army
Pacific Ocean Division, Corps of Engineers
Building 230
Ft. Shafter, Hawaii 96858

Dear Mr. Cheung:

Re: Review of Final Report, "Archaeological and Paleontological Investigation at Kalaeloa (Barbers Point), Hono'uli'uli, 'Ewa, o'ahu" by H. H. Hammatt and W. H. Folk, Archaeological Research Center Hawaii, Inc.

Thank you for your letter of 23 September 1981 soliciting a peer review of the above document. In undertaking this review at the Corps' request, I am providing you with my comments, opinions, and judgements as a professional archaeologist with more than 14 years of experience in Hawaii and the Pacific Islands. These views do not, however, represent official policy of the Bishop Museum.

In making my review and evaluation, I have paid particular attention to the several guidance documents, especially the Revised Scope of Work (Federal), and the Revised Research Designs (Federal and State). In addition, I have taken into consideration the "Guidelines for the Preparation of Barbers Point Archaeological Research Designs" of February 1979, included as a "research guidance document" in the Revised Scope of Work (Federal, p. 2). I have also been cognizant of the suggested guidelines for peer review of reports issued by the Society of Professional Archaeologists (October 9, 1978). Although I am submitting my review to you and not to any other agency or organization, I would like to request that it be forwarded by your office to the Advisory Council on Historic Preservation, and to the State Historic Preservation Officer. These agencies have been directly involved with the Barbers Point investigations, and ought to be informed as to the findings and opinions of the peer reviewers.

To begin, I must point out that I find little substantive change between the original Draft Report and the present Final Report. Most changes made in the Final Report are of a cosmetic nature (e.g. typographical errors corrected, though not always, e.g. spatial consistently misspelled 'spacial'), while the major problems of substance in the Draft Report remain in the Final Report.

Thus, nearly all of the problems raised in my earlier review of the Draft Report (dated 22 February 1981 and submitted to you) also pertain to the Final Report.

In a review of any archaeological investigation, the most important point is to determine whether the research objectives were adequately addressed. I therefore focus my review on the research objectives of the Barbers Point work, and on the adequacy of ARCH's attempts to achieve these objectives.

Research Objectives.

On pp. 5-6, Hammatt and Folk lay out five "research objectives" around which their archaeological investigations were oriented; these objectives are then evaluated on pp. 14-26. I will review each objective in turn:

1. The first objective was to develop a "firm stratigraphy and chronology for the sites and features of study areas", and clearly, this objective was fundamental to the success of the project as a whole. Unfortunately, the investigators have failed to meet Objective 1. What is most disturbing is that it would appear that datable materials are abundant in the Barbers Point sites, and that Hammatt and Folk simply did not avail themselves of the opportunity to have such materials chronometrically analyzed. For example, organic materials other than charcoal (e.g. shell, bone, sea urchin) could have been submitted for C14 age determination from a much broader sample of the prehistoric habitation features. Most critical is the absolute failure to ascertain the age of any of the bird bone deposits, for this problem is fundamental to the entire question of human prehistory and environment at Barbers Point. There is no excuse for not attempting C14 dating on samples of bird bone from the sinks (and, there are evidently large samples of non-extinct bird bone, such as that of the dark-rumped petrel, which could be sacrified for dating purposes). Furthermore, an effort should have been made to apply relative flourine and/or amino acid dating to the bird and rat bones from the paleontological sinks, to determine whether the rats are contemporary with the fossil birds. Certainly, the foremost research problem at Barbers Point is to determine the relationships between the extinct birds and man, a problem requiring utmost concern with chronology. It is inexcusable that so little effort was devoted to this problem.

The lack of adequate dating has implications for other aspects of the Barbers Point work as well: for example, on p. 16 we are informed that "the intensity of occupation of any particular site in the study area is difficult to assess because of the lack of datable material." It would appear that the problem was not a lack of datable material, but a lack of effort on the part of the archaeologists to avail themselves of all possible dating materials and techniques. (Similarly, on pp. 211-212, Hammatt and Folk dismiss Davis' argument concerning functionally-integrated residence groups, yet disproof of Davis' hypothesis could only be based on reliable chronometric data, which are lacking.)

The emphasis placed by ARCH on hydration-rind dating of volcanic glass flakes deserves comment. The hydration-rind method is not an independent chronometric technique, but is very much tied to C14 dating for control. Therefore, ARCH's emphasis on hydration-rind dating for primary chronological control, "supplemented by Carbon 14" (p. 13) is, in a manner of speaking, putting the cart before the horse. Further, to be even minimally useful, hydration-rind measurements must be used only when it is possible to control for glass chemistry and for effective hydration temperature. Neither of these have been determined in the Barbers Point case. These reasons alone are sufficient to reject outright the hydration-rind chronology given in Hammatt and Folk's report. (I would further question the qualifications of the ARCH team to carry out the thin-sectioning and measurement of hydration-rinds. I know of only two scientists in Hawaii with adequate training and practice to work on Hawaiian volcanic glass, and neither of these individuals was involved in the dating of materials obtained by ARCH.)

In sum, I completely reject the statement on p. 11 that "every effort was made to develop a diachronic sequence", and submit that Research Objective 1 was not even minimally achieved.

2. Hammatt and Folk have, in my opinion, done only slightly better with regard to their second objective, which was to define "site/feature functions, particularly specific functions of the habitation features". The principal method used to address this problem appears to have been that of plotting 'density contours' of midden and artifacts in order to ascertain spatial patterning over site areas. The use of this method is appropriate, and does contribute toward a resolution of Objective 2. The problem, however, is that Hammatt and Folk did not carry their analysis far enough. They have not, for example, analyzed the spatial distribution patterns of specific artifact types or categories over occupation surfaces, nor have they done this with categories of faunal or floral remains. Although they mention "size" of habitation features as an important variable, nowhere do they provide even most elementary statistical analysis of size variation in the Barbers Point habitation structures. Other analyses which would be of great value in sorting out inter-site variability would be the use of multi-variate statistical analyses (especially discriminant and cluster analyses) with structural, artifactual, and midden data. None of these were attempted by the investigators, even though they have become relatively standard analytical techniques in American archaeology. The statement (p. 21) that statistics could not be applied "because of the many different criteria used and the simple non-quantifiable nature of the criteria" is not acceptable. Many criteria relating to site function <u>are</u> quantifiable, and even for discrete data (absence/presence) there are a variety of similarity and distance coefficients which are applicable.

3. The third objective overlaps somewhat with the second objective and is focussed upon "definition of the subsistence and manufacturing activities and the nature of specific activity areas within habitation sites." My comments on Objective 2, above, are also applicable here.

I am particularly concerned here about several major problems and omissions in the collection and analysis of faunal and floral remains ("midden"). Although some basic midden data are presented in Table 3, no corrections are made for excavated volume (i.e. no concentration indices are calculated), hampering effective intra- and inter-site comparisons. Hammatt and Folk refer to the "extreme difficulty in calculating the volume of excavated units due to the wavy and frequently convoluted strata boundaries" (p. 178) but this problem could easily have been overcome by simple volumetric or weighing procedures in the field. The utility and representativeness of the midden data become more suspect when it is made clear that only ¼" mesh was used in screening (p. 178). The authors justify their procedure by citing tests made by Kirch at two sites on Hawaii Island. What they have failed to appreciate, is that the size distributions of midden particles can vary tremendously between sites, and tests should always be carried out on each particular site. Therefore, since Hammatt and Folk failed to conduct the appropriate tests, I cannot accept their statement that the use of ¼" mesh was "an insignificant skewing factor." Worse, since no tests were made, any archaeologist wishing to use their midden data in further analyses has no empirical basis on which to assess the degree of skewing.

While the molluscan remains have been identified to specific-level taxonomic categories (Table 3), the equally significant vertebrate remains have not been identified below the level of such general categories as "bird" or "fish". In a project of this scope, and given the stated research design, it is inexcusable that detailed specific-level identifications were not carried out on this material, and that the data were not presented in full tabular array.

I further question the scenario Hammatt and Folk present regarding the correlation between fish and shellfish with temporary and permanent sites (pp. 181-183). Their assumption that temporary sites should exhibit "low quantities of shellfish remains" is not borne out either by other studies in Hawaiian archaeology, nor by ethnoarchaeological studies of contemporary Polynesian subsistence practices. More important, Hammatt and Folk appear to be unaware of the work done by R. Cordy, R. Green, and others on the temporary/permanent habitation dichotomy in Hawaiian sites. No reference is made by Hammatt and Folk to this important and relevant literature.

4. The fourth objective concerns the nature and extent of environmental change. Largely due to the application of paleo-malacological and avifaunal studies, this objective has met with greater success than the others. Still, there are major problems. The failure to develop a reasonable chronology for Barbers Point means that we still do not know the time frame within which the environmental changes represented by the landsnail and avifaunal remains took place. Although the Revised Scope of Work (pp. 7-8) specifically refers to such techniques as sedimentology, non-dating geochemistry, pollen and opal phytolith studies, Hammatt and Folk have made no serious attempt to apply these or other analytical methods which might shed further light on the nature of environmental change in the area.

The authors repeatedly refer to "natural mixing of deposits" (e.g. p. 18) in the paleontological sinks, yet nowhere do they provide any justification for this assertion. On the contrary, Dr. Christensen and I have found that the stratigraphic distributions of both landsnails and vertebrate micro-fauna (lizards, rats) in the sink deposits indicate _no_ significant mixing. For example, bones of the historically-introduced _Mus musculus_ are found only in the top-most sample units, and not in the zone of birdbone concentration as Hammatt and Folk's statement would imply.

Hammatt and Folk have generalized from the unexpected finding of large quantities of the amphibious snail Assiminea nitida in one sink, to propose that mulching of sinks for agricultural purposes "might have been a general agricultural pattern throughout the area" (p. 19). This indeed is a likely possibility, but it is regrettable that no attempt was made to test this hypothesis through examination of spot samples from other sinks, a relatively simple task.

One of my greatest concerns with the present study is that the sample of excavated, avifauna-bearing sinks is woefully inadequate. Only one paleontological site with a relatively deep and well-stratified sequence (Site 2624) was studied in detail, yet it is this category of site that has yielded the internationally-significant remains of extinct birds. The paleontological sinks are also the only sites that have provided clear evidence of association between humans and the extinct birds. Hammatt and Folk provide a long list of "tested" sinks with demonstrated potential for further investigations (e.g. Sites 2798, 2799, 2731, 2713, 2714, 2716, 2719, 2622, 2762, 9655, 9656, 9659, 2623, 9669, and others). Given the demonstrated scientific and cultural significance of these sites, it would be a tragedy of unspeakable proportions if all of these resources are destroyed without further investigation. While Barbers Point is not the only site in Hawaii where extinct avifauna are present, it is unquestionably the most important of all such sites. In my opinion, the Corps of Engineers, as a federal agency, has an obligation to either protect or mitigate adverse impacts upon the Barbers Point cultural resources.* The incomplete nature of the present study renders it totally inadequate as mitigation.

5. Hammatt and Folk state that "it was possible to document the history of Hawaiian occupation at Barbers Point to the degree defined in the first four general objectives of the study". Since none of these objectives has yet been adequately met, it should be obvious that neither has Objective 5 yet received adequate treatment.

Research Problems

In addition to the five "objectives" reviewed above, Hammatt and Folk list (pp. 7-8) five "research problems", these being explicitly listed in the Revised Scope of Work (p. 5). Problems 1, 2, and 4 are essentially covered by Objectives 4 and 5, and hence my earlier comments apply to these points as well. Research problems 3 and 5, however, need to be considered separately.

Problem 3: Barbers Point Settlement Pattern. This problem was originally identified in the "Guidelines" of the Ad Hoc Committee (1979, p. 5), in which six specific questions were raised. Hammatt and Folk address settlement pattern on pp. 210-212 of their report; their cursory discussion is, in my opinion, totally inadequate and fails to address the problem. This is due to a failure to analyze (as opposed to merely collect) data in such a manner that settlement pattern relationships might be elucidated. There is no attempt to apply standard techniques of locational or distributional analysis to the data on

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*Because the extinct avifauna are directly associated with man, and critically important to an understanding of cultural development in Hawaii, the sinkholes are as much cultural resources as they are paleontological sites.

site distribution, nor any analysis of variability in site architecture. Even an elementary settlement pattern analysis of the Barbers Point data has yet to be accomplished.

Problem 5: The Barbers Point Cultural Pattern as a Unique Adaptation to a Unique Environment. This problem has been only minimally addressed by Hammatt and Folk. The kinds of specific analyses needed to address Problem 5--such as detailed faunal analysis--are entirely lacking.

Other Concerns

Under this heading, I will discuss two problem areas: sampling strategy and curation.

1. Sampling. The Revised Scope of Work (p. 5) calls for a specific, justified sampling strategy which will indicate "the relationships between various types of sampling strategies and field and laboratory analytical techniques, such as midden analysis, settlement analysis, and analysis of avifauna and land snails, etc." Nowhere in Hammatt and Folk's report do I find an adequate treatment of sampling strategy, nor any awareness of recent theoretical and methodological developments in the application of sampling designs in American archaeology. This report should, but does not, include a detailed and explicit discussion of sampling design at all levels of excavation and analysis.

2. Curation of Materials. The work at Barbers Point has resulted in a large and valuable collection of artifacts, zoological specimens, soil, and landsnail samples, as well as associated photographs and notes. As indicated in the SOPA Guidelines (p. 3), provision must be made for permanent curation of these materials, and furthermore, they must be "reasonably available for use by the archaeological community". Hammatt and Folk should include in their report a statement addressing these matters.

General Evaluation

I trust that the above comments are sufficiently detailed to document my overall evaluation of this report as inadequate and not fulfilling either the general or specific tasks set forth in the Revised Scope of Work and in the Revised Research Design. Furthermore, the report does not, in my opinion, meet the standards and reporting requirements set forth in 36 CFR Part 66 (42 Federal Register 5374, January 28, 1977). It is my professional opinion that the Corps of Engineers should under no circumstance accept the present Final Report as fulfilling the Scope of Work for cultural resources mitigation at Barbers Point.

In closing, one final point must be stressed above all others. It is standard procedure for archaeologists working on sites in the United States to evaluate the significance of prehistoric cultural resources in terms of 'local', 'State', or 'National' significance. In the case of Barbers Point, I have no hesitation in stating that the cultural resources are of international scientific significance. The demonstrated association of a large extinct avifauna with human activities, and the implication that man was directly or indirectly responsible for the extinction process, is a phenomenon of singular importance to the fields of archaeology, anthropology, ornithology, ecology, and biogeography. The Barbers Point materials rank in their international significance with the famous extinct moa birds of New Zealand, and with the Pleistocene megafauna of Australia. Given the incomplete and inadequate nature of the archaeological investigations carried out to date under the auspices of the Corps of Engineers, it will be an international scientific tragedy if the cultural-paleontological resources at Barbers Point are permitted to be destroyed without further research.

In writing this review I have endeavored to follow your request to be "frank, honest, scrutinizing", and to reflect my "best professional judgement." It is with regret that I have had to be so negative in my assessment. I can only hope that the Corps of Engineers will recognize its duty and responsibility to protect the unique and internationally-significant cultural and scientific information available at Barbers Point, so that future generations will not be deprived of its benefits.

Yours sincerely,

Patrick V. Kirch, Ph.D.
Anthropologist

PAUL H. ROSENDAHL, Ph.D., Inc.
Consulting Archaeologist

October 15, 1981

Chief, Engineer Division
Department of the Army
Pacific Ocean Division
Corps of Engineers
Building 230
Fort Shafter, Hawaii 96858

Subject: Requested peer review of third draft final report

Archaeological and Paleontological Investigation at Kalaeloa (Barber's Point), Hono'uli'uli, 'Ewa, O'ahu, Federal Study Areas 1a and 1b and State of Hawaii Optional Area I (Contract No. DACW 84-77-C-0010, Mod. No. P00001), by Archaeological Research Center, Hawaii, Inc.

Dear Sir:

Enclosed is my review of the third draft final report on the above subject investigation conducted for the Corps of Engineers. I trust the review will be of use to you in your final appraisal of the archaeological work that has been done for the Corps.

While I do appreciate the opportunity to review the report, I must state that the lack of serious attention paid to the earlier review of the initial draft of the report--the strong negative criticism of my own first review, as well as that of several other reviewers--almost caused me to decline reviewing the third draft, as I felt it would be a waste of my own time. I have, however, given considerable time and attention to this review of the third draft final report for two reasons: (a) your statement that unedited peer reviews will be appended to the end of the ARCH, Inc. report; and (b) the hope that my review will help to bring about further work at Barbers Point that might in some way still manage to address several of the significant archaeological research problems, and thus "salvage" something of value from the archaeological resources that have managed to survive the destruction of the work documented in the third draft final report.

If you have any questions or comments regarding my review--either the critical portions or the recommendations at the end, please feel free to contact me.

Sincerely yours,

Paul H. Rosendahl

Paul H. Rosendahl, Ph.D.
Principal Archaeologist

Encl.: Review 101481
(two copies)

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PAUL H. ROSENDAHL, Ph.D., Inc.
Consulting Archaeologist

October 14, 1981

TO: Chief, Engineer Division
Department of the Army
Pacific Ocean Division
Corps of Engineers
Building 230
Fort Shafter, Hawaii 96858

SUBJECT: Requested peer review of third draft final report

Archaeological and Paleontological Investigation at Kalaeloa (Barber's Point), Hono'uli'uli, 'Ewa, O'ahu, Federal Study Areas 1a and 1b and State of Hawaii Optional Area I (Contract No. DACW 84-77-C-0010, Mod. No. P00001), by Archaeological Research Center, Hawaii, Inc.

REVIEW PREPARED BY: Paul H. Rosendahl, Ph.D.
Principal Archaeologist

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Review 101481

INTRODUCTION

The purpose of this peer review is to evaluate the third draft final report on the archaeological and paleontological investigation conducted at Barbers Point by Archaeological Research Center, Hawaii, Inc. (ARCH) for the U.S. Army Corps of Engineers in conjunction with the development of the proposed deep draft harbor and support facilities at Barbers Point, Oahu. Prepared at the request of the Corps of Engineers, this peer review evaluates the investigations primarily in terms of their conformance to the specifications contained within the "Revised Scope of Work for Cultural Resources Mitigation and Data Recovery..." (3 April 1979), and particularly to the "Revised Research Design"; and secondarily in terms of conformance to established and generally accepted professional standards for archaeological research performance. In this fashion the review substantively addresses the suggested guideline questions for peer review of reports issued by the Society of Professional Archeologists (SOPA) (9 October 1978).

The present review of the third draft final report bears several similarities to the earlier review of the first draft final report submitted to the Corps of Engineers in March 1981. This is because most of the comments and evaluations made regarding the first draft are still directly applicable to the third draft.

Certain specific limitations of this review should be recognized. First, the review concentrates upon addressing major problems or issues. It is not intended to be a detailed technical review, though the third draft final report provides sufficient documentation of technical inadequacies. Nor is it intended to be a detailed listing of substantive content errors and inadequacies, though the third draft final report contains numerous specific examples that could be cited.

Second, there is the difficulty in reviewing the report that is caused by the absence of several important pieces of data. The major difficulty encountered earlier in preparing the initial review of the first draft--the absence of almost 50 % of the graphics (plan maps, sections, and photographs)--has been answered in large degree by the presence of most of these illustrations in the third draft; however, certain specific important pieces of graphical data are still missing. The most significant missing items are (a) an overall study area map indicating the locations of all known archaeological sites (approximately 148 sites) within the project area--not just those that were "salvaged" (26 sites); and (b) cross-sections for many of the excavated sites (sections provided for only 9 of 26, or c. 35 %, of the sites).

In terms of general format, this review will first make a general overall statement of evaluation, then will consider the major work tasks of the research and third draft final report in terms of major issues and problems, and will conclude with a final evaluation of the work and some recommendations as to how the numerous deficiencies of the archaeological work conducted to date might be remedied to some extent. One final limitation must be made explicit. The following review comments apply only to the archaeological portions of the work and report done directly by ARCH, Inc., and not to the separate independent consultant reports that deal respectively with the paleontological salvage (Appendix I, by Olson and James) and the non-marine molluscs (Appendix II, by Kirch and Christensen). Considered independently, these two reports are both competent pieces of work, and it is regretable that the findings of these studies of the fossil and subfossil avifauna and the land snails have not been utilized or integrated into the archaeological portion of the third draft final report in any sufficient or meaningful manner.

GENERAL EVALUATION STATEMENT

Detailed critical examination and evaluation of the third draft final report, and consideration of the report in terms of the several documents provided earlier by the Corps of Engineers to aid in the review and evaluation of the report (Inclosures 2 through 8, letter of 12 February 1981), provides substantial evidence that the archaeological investigation conducted at Barbers' Point has failed to achieve the major overall study objective stated in the "Revised Scope of Work..."--that is, the archaeological investigation that is documented in the third draft final report does not in any way constitute adequate mitigation of the adverse effects of the proposed harbor development construction on the important cultural resources present within the Barbers' Point Harbor Archaeological District.

This failure to achieve the major study objective has resulted from (a) in general the lack of compliance with the various guidelines contained within the several guidance documents listed in the "Revised Scope of Work...", and (b) more specifically and directly both the inadequate performance and lack of performance of the various work tasks detailed in and contractually required by the "Revised Scope of Work...." With regard to the eight guideline questions for peer review suggested by SOPA that the Corps of Engineers requested (letter of 23 September 1981) reviewers to consider in their evaluations of the third draft report, a uniform negative response must be made to all eight questions.

RESEARCH DESIGN

The "Revised Scope of Work..." specifies the preparation of a research design that provides "...for recovery of an adequate and usable sample of data on those significant research topics that can reasonably be addressed" (Item 5.(1)(a)). Such a research design thus provides the scientific framework within which to carry out the subsequent archaeological investigation. The third draft final report has several serious problems relating to the research design--both the research design document itself, and the subsequent performance of work in accordance with the research design.

First of all, the research design overall is itself inadequate. There is no critical analysis of previous archaeological research done in the Barbers' Point area. The section entitled "Previous Research" is simply a descriptive summary--little more than an ennumeration--of the nature and intensity of prior archaeological projects. An adequate analysis of this previous research would have concentrated on the results of the previous research, and the explicit use of these results to formulate research objectives, specific research hypotheses, and practical verification strategies for testing such hypotheses.

Secondly, the so-called "testible hypotheses" presented in the third draft final report (pp.8-9) as aimed to address the five original research problems are not really testible hypotheses. At best, some are general assumptions, postulations, inferences, or self-evident observations concerning the nature of Hawaiian settlement and occupation at Barbers' Point. Others are simply general, basic archaeological assumptions concerning the nature and patterning of archaeological data. None of the nine "testible hypotheses" are hypotheses in the scientific sense--that of explanation, dealing with relationships between variables in terms of determinative relationships, and not simply descriptive accounts of static spatial and temporal distributions of archaeological data. Hypotheses are directed at answering questions of "how" and "why" specific variables within the archaeological record are related, and as such are meant to go beyond simple questions of "where", "when", "what", and "who".

A third serious problem with the research design, and thus with the subsequent field work and report, relates to inadequate consideration of the nature of the archaeological data involved, and any strategies for sampling this data. The third draft final report never seriously considers the basic question of specifically what constitutes "an adequate and usable sample of data". This unanswered question applies to all levels of study--from the universe of sites, to specific sites, to specific features within sites, to the location of specific excavation units within sites and features, to specific methods and techniques of data recovery through excavation. Such basic essential questions as how samples at different levels are related, criteria and methods utilized in the selection of "samples", the validity of samples, and potential biases and means for controlling such biases do not appear to have been seriously considered at all.

Closely related to the many problems involving sampling is the issue of the nature of available data present and how one could go about testing any hypotheses. The third draft final report fails to consider how different kinds of data could be used to test specific hypotheses, much less consider what would constitute adequate testing and subsequent verification or rejection and modification of tested hypotheses. Furthermore, the report section on "testible hypotheses" gives no indication of any understanding that the archaeological testing of hypotheses involves the elimination of alternative explanations for the patterning of the recovered archaeological data.

One of the most disturbing aspects of the third draft final report relates to the five original major research problems that were to be addressed by the archaeological investigation. As indicated in the "Revised Scope of Work...", the archaeological work was required contractually to address these major research problems. The overall conclusion reached earlier in the March 1981 review of the first draft final report was that the archaeological investigation reported in the first draft final report totally failed to address adequately any of the five major research problems contained in the "Revised Scope of Work...". The response presented in the third draft final report (p.7) seems to be an effort to evade responsibility for failing to address adequately the major research problems by making the specious claim that the "...degree to which the original research goals [problems] have been met does not provide a basis for evaluating the effectiveness of the research but is a statement on the amount and kind of data found in the sites."

If it were true that the amount and kind of data were either inadequate or inappropriate for addressing the original research problems--an argument itself not at all supported by the available evidence--then such a situation would have been obvious upon the completion of the archaeological testing phase of the work conducted prior to the salvage excavations. At that point, prior to beginning any salvage excavations, the original research design should have been modified, and an explicit, written research design reflecting changes in the major research problems to be addressed--and specific strategies for addressing them--should have been prepared, and possibly even submitted to the Corps of Engineers for approval. Apparently such a reconsideration and modification of the research design was never contemplated, or it would have been presented in the first draft final report. Quite to the contrary, the first draft final report (p.14) explicitly claimed that the original research problems had been adequately addressed by the successful achievement of the various research objectives through which the original research problems were to have been investigated. The reason offered in the third draft final report for the failure to address adequately the original major research problems is a transparent, clearly <u>post facto</u> effort to pass over that failure by providing a non-substantive response to the first draft final report criticism.

ARCHAEOLOGICAL DATA RECOVERY

The "Revised Scope of Work..." specifies that the archaeological field work--the data recovery--be carried out according to the approved research design (Item 5.(2)). Based on the documentation provided in the third draft final report, it is apparent that there are several serious problems with and deficiencies in the archaeological investigation that are related directly to the conduct of the data recovery field work. Perhaps the most serious problem involves the same question of sampling. Previous comments concerning problems with the research design have already touched upon this topic, but further comment is required in connection with the actual field work. There are no discussions of or justifications for the actual samples of data collected in the field--why certain sites and features rather than others were excavated, where or on what bases excavation units were placed in relation to structural remains, the amount of square area actually excavated, and so on. Taken together, these points suggest a lack of any consideration of, or perhaps basic understanding of, what the recovered "samples" of data mean in terms of being representative samples--either qualitative or quantitative--of the totality of data present. Furthermore, no consideration is given really to questions regarding potential biases in the recovered data that might result from specific data recovery methods and techniques utilized.

The problem of inadequate sampling is illustrated by considering the portable remains--the artifacts and midden materials--recovered through the screening of excavated fill. The approved "Revised Research Design" states that 100 % samples of midden would be collected (p.11) (no screen mesh size mentioned), but the third draft final report indicates that this recovery procedure was not precisely followed. Specific procedures actually used are somewhat uncertain. One place in the third draft final report (p.11) states that excavated fill was processed through 1/4" and 1/8" mesh screens with 100 % samples being collected from the 1/4" screens and basaltic glass and other artifactual materials being collected from both the 1/4" and 1/8" mesh screens. Elsewhere the third draft final report (p.178) states that following similtaneous screening through 1/4" and 1/8" mesh screens, 100 % midden samples were collected from the 1/4" screen and "[a]ll material retained in the 1/8-inch screen was discarded after collection of all artifacts including basaltic glass and <u>all midden materials not present in the 1/4-inch screen</u>" [emphasis added]. Based on this statement, it is obvious that the recovered midden samples are not true quantitative samples, but questionable qualitative samples recovered through procedures involving the uncontrolled biases of the specific individuals conducting the screening.

A considerable number of previous archaeological excavations in Hawaii--both at sites in the Barbers' Point area and elsewhere--

have demonstrated that the use of 1/4" mesh screens is very often an inadequate technique for the recovery of reliable, representative samples of portable remains, and that in most instances 100 % collection of all materials from the 1/8" mesh screens is essential for qualitative analyses, and particularly for any quantitative analyses. Furthermore, hand-sorting of the 1/8" screen component in the laboratory is often necessary to recover a significant portion of the small artifacts and artifact fragments. It is quite possible that the recovery techniques used in the field work at Barbers' Point are directly responsible for collection of only 55 pieces of basaltic glass in an area where similar sites have yielded substantial numbers of pieces. An on-site inspection of the screening dump piles could certainly be instructive.

The assumption stated in the third draft final report (p.178) that sampling bias introduced by the use of 1/4" mesh screen was insignificant is certainly an assumption that should have been, and could have easily been, tested during the work at Barbers' Point. The explanation that such tests done earlier by another researcher at sites in two locations on the west coast of Hawaii Island had been interpreted as indicating no significant skewing of midden samples from the use of 1/4" mesh screen alone is an inadequate reason for failing to utilize the Barbers' Point excavations as an excellent opportunity to test such assumptions--to confirm or deny the validity of such sampling procedures.

On the basis of the third draft final report, it is apparent that no provision was made for the systematic inspection of the residues that passed through the 1/8" mesh screens--no attempts at such techniques as flotation, or even simple visual inspection using low-power magnification. Such procedures could quite likely have revealed the presence of very small fish bones, marine and non-marine mollusc shells, and even artifacts which have been known to pass occasionally through 1/8" mesh screens.

The information presented in the third draft final report makes it very difficult, if not impossible, to evaluate the intensity of the effort involved in the field recovery of data. The report contains little or no useful information at all regarding such basic and standard details as dates of field work and number of field work days, size (number of people) and organization of field crews, man-hours expended in field work overall--much less man-hours of investigation directed at specific portions of the field work, or estimated volumes of deposit excavated at various sites. All of these kinds of information are needed to evaluate accurately the reliability of the recovered data.

The third draft final report also fails to provide information sufficient to evaluate how adequate or comprehensive was the recording of field data. For example, there is little or no mention of possible specific difficulties encountered in the various excavations, or in the definition of various stratigraphic units, and many of the site excavation descriptions do not even have stratigraphic cross-sections presented with the plan maps. Overall there are numerous questions regarding the nature, quality, and reliability of the recovered field data presented in the third draft final report, but to answer most of these questions would require actual on-site field inspection of the sites and excavation areas.

An example of one specific, very important question that could be answered only by on-site field inspections relates to the cultural deposits identified at several of the sites. While the third draft final report maintains in virtually every instance that the excavated sites were single component sites, the graphical data provided for four of the sites suggests the distinct possibility that several--perhaps all four--of the sites are actually multiple component sites--ones with subsurface components that had been deposited prior to the construction of the surviving surface structural remains. Such subsurface components could quite likely not be related at all to the later surface structural manifestations.

Site	Figure No.	Comments
2712	9-13	Plan maps show large hearth situated stratigraphically beneath structure wall
2731	24	Cross-section shows major cultural layer situated stratigraphically beneath and extending laterally beyond structure walls
9682	36	Cross-section shows major cultural layer extending laterally beyond structure wall
2787	59-63	Plan maps show portion of hearth situated stratigraphically beneath structure wall

It should further be noted that the above list of problem sites includes the only two sites that were dated during the archaeological investigation of sites at Barbers' Point--Sites 2731 and 9682.

One small, but potentially very significant, set of changes in wording noted between the first and the third draft final report descriptions of field and laboratory methods utilized for the conduct of the archaeological investigation suggests a possible explanation for many of the inadequacies of and problems with the recovery and subsequent treatment of field data. While the first draft final report stated that both recovery of field data and subsequent processing and analyses of portable remains were carried out according to "standard archaeological field methods" (p.58) and "standard archaeological laboratory methods" (p.59, the third draft final report--in curious contrast--has been changed to state that such work was carried out according to "standard ARCH [Inc.] field methods" (p.67) and "standard ARCH [Inc.] laboratory methods" (p.69). On the basis of first-hand familiarity with several archaeological projects carried out by the personnel of ARCH, Inc., it both can be and has been substantively documented that many of those same "standard ARCH" methods do not comply with the standards of research performance ascribed to by professional archaeologists.

HISTORICAL DATA RECOVERY

The "Revised Scope of Work..." called for historical research "...to the extent necessary to document the history of Hawaiian and Western occupation and land use at Barbers' Point after European contact (A.D. 1776) and the relationship of this historic occupation and land use to changes in the study area's environment" (Item 5.(3)). There are at least two serious problems reflected in the third draft final report which relate to the performance of this major work task. First of all, the report does not adequately describe or really even consider the effective environment of the study area--neither the marine nor the terrestrial aspects--in any kind of detail, much less with any emphasis upon the relationship of the environmental setting to the archaeological remains. The report should contain a sufficiently detailed description of the present physical environment--both marine and terrestrial, an analysis of all available data relating to known and/or postulated past changes in the environmental setting of the study area, and an evaluation--based on the best available data of all kinds--of the environmental setting of the study area in terms of potential for aboriginal Hawaiian settlement and occupation.

The second major problem relating to the historical data recovery involves the historical background research. The "Revised Scope of Work..." calls for the research to deal with the history of Hawaiian and Western occupation and land use for the full span of time from the point of European contact (c. A.D. 1776). In direct deviation from this instruction, the third draft final report concentrated only upon the history of military occupation and land use for the period 1940 through 1946. In addition to not conforming to the scope of the contractually required historical research, the military history presented in the third draft final report--Appendix III: A Study of the Wartime History of Camp Makakole, 1940-1946--is considerably out of proportion to the rest of the report, particularly since this historical study provides little in the way of information directly relevant to any explication of "the relationship of this historic occupation and land use to changes in the study area's environment", much less how such occupation and land use patterns could have affected--and as such be reflected in--the surviving archaeological remains of the Barbers' Point area.

The investigation of the history of Hawaiian and Western occupation and land use requires historical documentary research which covers the entire historic period from the time of European contact to the present. Such research would incorporate data from a wide range of ethnohistoric, archival, and other documentary and informant sources, and would consider--at the very least--the early history of the area, specific land tenure history, and the variety of historic period land use and modification patterns. The third draft final report statement (p.19) that "no archaeologically expressed evidence of cultural transition is present in the excavations..." is really unacceptable and reflects at the very least, a failure to conduct research into available relevant historical documentary sources of many different kinds.

DATA ANALYSIS AND REPORT PREPARATION

The "Revised Scope of Work..." calls for analyses of recovered data to be carried out in accordance with the approved research design, and indicates further that the final report shall be "an objective final product"--one which documents that the archaeological contractor did "...properly, appropriately, and adequately include and thoroughly investigate all areas and sources of information pertinent to an objective analysis and investigation specified in the Scope of Work." The third draft final report clearly fails to accomplish these aims.

One of the most serious problems is the generally inadequate presentation of descriptive data. The professional standard for archaeological reports is the descriptive presentation of data in sufficient quantity and detail so as to (a) indicate clearly the bases for conclusions and interpretations given by the authors, (b) allow other archaeologists to evaluate in depth these conclusions and interpretations, and (c) permit other archaeologists to arrive with some assurance at other possible alternative conclusions and interpretations--if so justified--on the basis of the same data.

The level of analysis afforded the recovered data is particularly disturbing. Neither the artifacts nor the midden materials are really analyzed in any useful manner. In neither case are the data presented with sufficient clarity and detail so as to permit other archaeologists to utilize the data in making meaningful comparisons to assemblages or remains from other archaeological sites.

The report section on dating is difficult to evaluate. Comments regarding the questionable scarcity of basaltic glass pieces that might have been used for dating have already been made. The section on dating fails both to offer any plausible explanation, or to include discussions concerning the relevant problems with and limitations of the use of basaltic glass and radiocarbon dating techniques with the Barbers' Point samples. A much more serious and obvious inadequacy of the dating work done as part of the archaeological investigation is the failure to utilize, or apparently even consider, alternative dating techniques--absolute or relative--using shell and bone materials from the various excavations. This failure is particularly incomprehensible and unexcusable in view of the nature of the various major research problems requiring the establishment of a firm chronological framework, and the purported scarcity of opportunities for basaltic glass or radiocarbon dating.

The paucity of accurate and reliable hard descriptive data in the third draft final report overall, together with the lack of analysis of the field data from the structural remains and the excavations, and the subsequent lack of analysis of the recovered portable remains--both artifacts and midden--correlates clearly with the totally inadequate concluding section of the report, the "Barber's Point Perspective". There is no real integration of data--either of the various kinds of the archaeological data, or of the archaeological data with the data and interpretations of the consultant reports on the avifauna and the land snails (Appendices I and II). Given the absence of any interpretations or conclusions that are firmly and objectively based on the recovered data, it is easily understood also why the third draft final report does not contain any critical self-evaluation of the archaeological investigation overall.

CONCLUSION

The obvious conclusion of this review, based on a critical examination and evaluation of the third draft final report, is unavoidably and overwhelmingly negative with regard specifically to the archaeological investigation. Only the appended consultant reports on the avifauna and the land snails represent positive research contributions. In summation, the third draft final report has failed to achieve the overall major objective of the Barbers Point investigation. This failure is the direct result of both inadequate performance and lack of performance in terms of the major work tasks required by the "Revised Scope of Work...." The final recommended "complete archaeological clearance for the entire project area" (p.28), and the implied lack of any need for any further archaeological research, certainly is neither justified nor supportable on the basis of the archaeological investigation documented by the third draft final report.

The most disturbing conclusion overall is that the archaeological investigation has totally failed to address adequately any of the five major research problems contained in the "Revised Scope of Work..." (p.5). The basic and guiding philosophy of the Federal historic preservation program is that archaeological resources are important wholly or in part--wholly in the case of the Barbers' Point resources--because they may contribute to the study of important research problems. And therefore archaeological research, addressing significant questions about the past, is in the public interest. This then is the justification for the spending of public monies for archaeological research. The unavoidable conclusion of this position must be that the archaeological investigation conducted at Barbers' Point by ARCH, Inc. for the Corps of Engineers, as documented in the third draft final report, has been a waste of public funds. By failing to address the major research problems as required by the "Revised Scope of Work...", the archaeological investigation has accomplished the destruction of important sites and the loss of valuable data, without any significant research return for the expenditure of time and money.

The third draft final report submitted by ARCH, Inc. is a specific example of why archaeology and archaeological research is regarded by many people, and by several government agencies as well, as a waste of public monies. By the failure to address adequately the the significant major research problems, the report stands as an unfortunate example of the all-too-common brand of archaeological work that constitutes little more than documentation of the destruction of archaeological sites.

Furthermore, the third draft final report demonstrates a disregard for professional standards and ethics that must be considered unacceptable in anyone purporting to be a professional archaeologist. The overall response to the strong and wide-spread negative peer reviews of the first draft final report--as this response is expressed by the changes, deletions, and additions found in the third draft final report--would appear to indicate a broad-scale general attempt to avoid, ignore, mislead, and otherwise confuse, rather than clarify or adequately address directly, most of the critical issues and problems raised by the various peer reviews of the first draft final report.

RECOMMENDATIONS

The following general and specific recommendations are offered in the hope that they might help to accomplish two objectives: (1) assure that future archaeological investigations done for the Corps of Engineers will be formulated and conducted in such fashion as to achieve adequate mitigation of adverse effects of any Corps projects upon important archaeological resources, and thus represent a significant research return on the expenditure of public monies; and (2) suggest a specific course of future action that would attempt to "salvage" something of value from the salvage excavations conducted at Barbers' Point by ARCH, Inc.

GENERAL RECOMMENDATIONS FOR FUTURE ARCHAEOLOGICAL INVESTIGATIONS

The basic recommendation is to involve knowledgeable and competent professional archaeologists in all the aspects of project work, including preparation of scopes of work, review of proposals, monitoring of in-progress work, and review of resulting reports. The SOPA "Suggested Guidelines for Peer Review" are explicitly "designed primarily to maintain quality in the whole process of archeological contract work", and could serve easily as an appropriate model for the Corps of Engineers. In contracting for archaeological work, the Corps should deal only with responsible professional archaeologists, and refuse to be satisfied with, to accept, or to pay for inadequate archaeological work. Above all, the Corps of Engineers should demand that professional standards of performance and ethics--such as those of SOPA--are adhered to by all archaeological contractors.

SPECIFIC RECOMMENDATIONS FOR BARBERS' POINT

While the archaeological investigation conducted at Barbers' Point--as documented by the third draft final report--strongly motivates the wish to re-do (so far as possible) the entire program of archaeological research from the beginning, such a desire is impractical for several reasons--both archaeological and other. The only practical alternative would be to attempt to address a careful selection of the most important specific issues and problems that could still reasonably be investigated. A suggested approach could include the following steps:

1. Corps of Engineers initiate and sponsor formation of a research committee of professional archaeologists working in Hawaii for the cooperative investigation of the archaeological resources at Barbers' Point;
2. Research committee then would initially discuss all aspects of work done to date, and tentatively form a list of priorities--as specific as possible--to be addressed through further work;
3. Research committee--most likely represented by selected members--would then conduct a detailed review and evaluation of all available field records and documents, and a subsequent on-site field inspection of sites, with the purpose of determining the nature and reliability of of available data and existing site conditions, and how these factors relate to the priorities and practicalities of specific future research tasks and problems;
4. Research committee to discuss and finalize research priorities and strategies, and prepare formal recommendations for submission to the Corps of Engineers;
5. Field investigations carried out;
6. Analyses of recovered data carried out;
7. Final report prepared and submitted.

It is suggested that Steps 1-4 might be appropriately carried out under the auspices of the Society for Hawaiian Archaeology (SHA), an incorporated organization to which virtually all archaeologists working in the State of Hawaii belong. It is further suggested that the possibility of SHA being contracted to carry out Steps 5-7 as a cooperative investigation that would bring together archaeologists with a variety of skills and affiliations is a possibility for careful consideration. Precedents for contracting similar non-profit organizations to conduct public archaeological investigations are known to have been successfully completed on the mainland.

One final recommendation should be made. Further paleontological research on the avifauna and the land snails recommended in the appended consultant reports (Appendices I and II) in the third draft final report must be given serious consideration and support. Organization and conduct of such further research would most profitably be done in careful coordination with further archaeological investigations.

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William K. Kikuchi PhD.
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October 16, 1981

Kisuk Cheung
Chief Engineering Division
Dept. of the Army
Pacific Ocean Division
Corps of Engineers
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Thank you for allowing PAPA to review Dr. H.H. Hammatt and Mr. William H. Folk's report: Archaeological and Paleontological Investigation at Kalaeloa (Barber's Point) Honouliuli, 'Ewa, O'ahu Island, Federal Study Areas Ia and Ib, and State of Hawaii Optional Area I.

In order to avoid rewriting a shorter assessment report of a voluminous report, I will, for everyone's convenience, reduce my evaluation to a few pertinent paragraphs. Similarly, I wish to note that because of the lateness of our receiving your evaluation request, I, as president of PAPA, and Dr. Kenneth P. Emory, another respected member of PAPA, will probably be the only ones replying. We do not imply we are the voice of PAPA. We are saying that due to time constraints, we will try to present our individual views and hope our membership will agree with our evaluations.

Dr. Hammatt and Mr. Folk are both members of PAPA. This in no way influences my evaluation of their report. My methodology was to read as critically as possible all sections of the report and to make notes as to the areas of interest and those of obvious mistakes. I simply weighed each section against the requirements as stated in their scope of work, research design and methodology. I had no communication with any of the authors during the time of evaluation.

Evaluation. The Scope of Work pp. 5 and 6 and the Research Design, pp. 7,8 and 9 are explicitly stated and have been adequately met. Where ARCH's report states that the area, once excavated, can be "cleared", Olson and James and Kirch and Christensen recommend further work in order to salvage the sinkholes. ARCH's recommendation concern the archaeological nature of the impacted sites; the others (Olson and James and Kirch and Christensen) deal with the paleontological value of the sinkholes. This appears to be the only area of conflict, and it in essence is not a conflict as one recommendation is based on archaeology and the other on paleontology.

The methodology has been adequately stated and is sufficient for the work accomplished. Because of the serendipitous paleoavaian and molluscs finds, the significance of the area and the recommendations concerning it can be altered toward a paleontological value, and, if, indeed, salvage is desirable in the area to be destroyed, then considerable more sinkhole excavations need to be done. As Oslon and James state, the sample for paleoavian remains needs to be increased.

Hammatt and Folk's and Albert's reports are well organized, well illustrated and complete with tables. In contrast, the excellant studies by Olson and James, and Kirch and Christensen could have been even better had they contained illustrations.

I tried within my time table to check all the data contained in the reports, i.e., text plus appendices. I did note typographical errors, which were minor, and the exclusion of a formula in Kirch and Christensen's article on page 259, i.e., Proportional Similarity Index. I found the reports, to be of considerable interest and value in my work as another refernce publication in Hawaiian prehistory. I consider this entire report to be of value for the following reasons:

1. It readdresses the significance of what we consider to be a marginal to submarginal karstic arid landscape in terms of its cultural use and of its now scientific i.e., paleontological, value. In other words, significance cannot be judged by visual inspection alone or by today's land use standards.

2. It hypothesizes functional use of certain types of sites by the locational pattern of midden.

3. It is interdisciplinary and of wide temporal scale, i.e., it ranges from prehuman to World War II.

4. It contains significant paleoavian findings by Olson and James and a virtual rewriting of the "book" on Hawaiian adaptation, radiation, and extinction of its birdlife.

5. It contains significant findings by Kirch and Christensen on non-marine molluscs and their relationship to the paleoecological history of the site area.

6. It contains an excellant recounting of the military history of Camp Makaole and its effects on the area.

In conclusion, I can state that the report was well done, well organized, multi-disciplinary, and contained some monumental studies from which the paleoecology of the Hawaiian Islands will be virtually revised.

Sincerely yours,

William K. Kikuchi

William K. Kikuchi PhD.

President PAPA

SOCIETY FOR HAWAIIAN ARCHAEOLOGY

P.O. Box 22911 • Honolulu, Hawai'i • 96822

20 October 1981

Mr. Kisuk Cheung
Chief, Engineering Division
U.S. Army Corps of Engineers, Pacific Ocean Division
Building 230
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Thank you for your undated letter, received 23 September 1981, and the opportunity to review the revised final draft on "Archaeological and Paleontological Investigation at Kalaeloa (Barber's Point), Hono'uli'uli, 'Ewa, O'ahu, Federal Study Areas 1A and 1B and State of Hawaii Optional Area 1" prepared by Hallett H. Hammatt and William H. Folk of Archaeological Research Center Hawaii Inc.

We have formed a new ad hoc committee in order to maintain objectivity by involving more of our membership in the Peer Review Process. Each committee member has reviewed the revised final draft report, and used the same documents in comparing this draft to the earlier one given to the Society for Hawaiian Archaeology for Peer Review. Then, the committee as a whole met and discussed the revised draft at length.

In addition to the SOPA Guidelines, Revised Scope of Work, and Revised Research Design, the committee used as primary review criteria the "Summary List of Comments" contained in a letter that your office sent to Dr. Hammatt on 23 March 1981. These documents, and the original set of peer reviews*, have been referred to in the process of comparing the two draft reports. We used this comparison to determine the extent to which the final revised report has satisfactorily addressed the multitude of both general and specific comments supplied by the previous reviewers.

A critical examination of the revised report reveals that -- apart from the addition of previously omitted graphics, basaltic glass and radiocarbon dates, and the master artifact catalog -- the final product is substantially the same as the widely condemned earlier drafts. There is little or no evidence that the authors of this report have taken serious notice of the review comments provided them by the Corps of Engineers. With reference to the "Summary List of Comments", we are of the firm

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* We refer here to the peer reviews by Davis, Hommon, Kirch, and Rosendahl.

opinion that of the total 21 items listed only numbers 3, 4, 7, 8, and 9 have been satisfactorily addressed. Moreover, these five items are the least consequential from the larger perspective of report adequacy, and amount to little more than cosmetic changes.

We are frankly surprised that the criticisms made by the original reviewers appear to have been ignored by Dr. Hammatt and Mr. Folk in their revision of the report. A point-by-point critique from the current SHA Peer Review Committee would thus be redundant since virtually no substantive (and few stylistic) corrections have been made. For the sake of brevity, the members of this committee are prepared to state categorically that, in our best professional judgement, the revised final draft report fails to satisfy the Scope of Work Requirements: the substantive comments of the previous reviewers still apply. In addition, the revised report does not comply with the Federal regulations and legislation under whose aegis the work was performed. Furthermore, the revised report does not conform to the generally accepted guidelines used by the Advisory Council on Historic Preservation in evaluating reports produced in the course of work for that agency. Finally, we defer to the criticisms made in the previous set of peer reviews in answering NO to all eight of the guideline questions for report review issued by the Society of Professional Archaeolgists.

Again, thank you for the opportunity to review and comment on the revised report, and we trust that our remarks will be of use to the Army Corps of Engineers. Should you have any questions regarding this review, you may contact the Society at the above address.

Sincerely,

Patrick C. McCoy

Patrick C. McCoy, PhD
Chairman, Ad Hoc Committee
to Review the Hammatt/Folk
on Barber's Point

Jane Allen-Wheeler

Jane Allen-Wheeler
Committee Member

Laura A. Carter

Laura A. Carter
Committee Member

Sara L. Collins

Sara L. Collins
Committee Member

Hand delivered to D. [illegible] 11 March 1981.

SOCIETY FOR HAWAIIAN ARCHAEOLOGY

President:
Patrick V. Kirch
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Honolulu, Hawai'i 96819

March 11, 1980

Mr. Kisuk Cheung, Chief
Engineering Division
U. S. Army Corps of Engineers Division
Pacific Ocean
Building 230
Fort Shafter, Hawaii 96858

Dear Sir:

Thank you for the opportunity to review the report on the "Archaeological and Paleontological Investigation at Kalaeloa (Barber's Point) Hono'uli'uli, Ewa, O'ahu, Federal Study Areas 1a and 1b and State of Hawaii Optional Area 1" by Hallett H. Hammett and William H. Folk. The Society for Hawaiian Archaeology does not have a standing committee for peer reviews and as a result an ad hoc committee,of which I am the chairman, was formed for the specific purpose of reviewing this report. Each of the committee members has reviewed the report and we have all discussed it at length. In addition, we have considered a letter we received from Dr. Carl C. Christensen, a co-author with Dr. P. V. Kirch of Appendix II of the subject report.

The deficiencies of the subject report fall into two major categories: (1) mechanical problems and (2) general problems. Mechanical problems plague the entire document and make the reviewers task an onerous one. Typographical errors abound; grammatical mistakes are unacceptably frequent; non-standard, ill defined and infelicitous terminology obscures the content and the intent of many of the author's propositions and contentions; and the absence of nearly half the figures and illustrations, the discussion of the chronometric data, table 7 and the entire artifact appendix make the entire document so incomplete as to render any review extremely difficult. We do not have the inclination or the time to undertake the task of editing the report. We presume that subsequent editing and proof reading, as well as inclusion of the absent figures and other data, will enhance the readability and quality of the report. Correction of all the mechanical problems however cannot remedy the fundamental general difficulties apparent in the report.

Virtually no attempt has been made to relate the data from the study area to the results of the previous and on-going research at Barber's Point or anywhere else in Hawaii. The consideration of observations, generalizations and hypotheses generated elsewhere in the vicinity and throughout Hawaii is a very obvious and fundamental ommission of this report

The chronological framework of the study area is not thoroughly discussed anywhere in the document. In spite of the problems with available chronometric samples, (both basaltic glass and carbon), a more complete picture of the chronology of the study area could have been constructed with the use of comparative data from other portions of Barber's Point as well as inferences from the study area samples themselves and the stratification within the subject area sites.

The problem of the relationships between man and the extinct avifauna is not adequately addressed. In dealing with such an important problem in an area that is uniquely suited for its solution, every possible effort should be expended to that end. Flourine and amino acid racemization analyses have yet to be applied to avifauna bones in the deposits. Such analyses should provide valuable additional data. Pollen analyses, as well as sediment analyses aimed at gathering paleoenvironmental and depositional data are also necessary.

The midden data collected during the excavations are not tabulated or analyzed in sufficient detail. it is standard practice to present the midden contents of each excavated site in a table arranged by excavation unit (usually 1 x 1 meter squares), by level or layer and by faunal and floral species. While the midden contour maps in the subject report are useful in terms of understanding general distribution of midden throughout the sites, tables such as those described above are necessary for distributional and comparative purposes.

Analyses of the artifacts recovered and their intra and inter-site distribution are very limited. For example, little attempt is made to determine correlations between quantity and types of artifacts on one hand and site type, size, location or midden contents on the other. No attempt is made to explain or even mention that 48 of the total area's 55 samples of basaltic glass came from one site (page 104). In one of the few cases where artifact assemblages are mentioned, contradictory statements are made. On page 143 it is stated that site 2710-2 and 2710-5 were elements in a kauhale (household) because they had "similar assemblages"; but on page 178 they are said to "have significantly different artifact assemblages". No mention is made of the apparent lack of correlation between the amount of fish bone in a site and the number of fishooks found.

There are a number of problems with the treatment of the cultural strata in the excavated sites. It is assumed, for example, that in all sites, stratum I is a mixed layer and that its contents were churned up from stratum II. In sites such as 2701-1 (page 70, figures 15 and 16) however, the distinctly different midden distribution patterns seem to suggest that stratum I is, at least in part, evidence of a later occupation. The absence of cross section drawings in many sites increases the reader's problems in interpreting the data as presented.

The distribution and inferred function of the stone structures is inadequately addressed. For example, the stone structure in site 9682 (pages 99-104) is scarcely more than a square meter in floor area, yet it is associated with the heaviest midden concentration in any of the sites. No mention is made of this combination of factors nor is any attempt made to explain it. It is stated in several site descriptions that the stone structures were constructed at the beginning of a site's use. In the few cross sections that are available, the foundation stones rest at a level well above the base of cultural stratum II (e.g., page 100, figure 36; page 104) indicating that at least portions of the structures were constructed at some time after the sites were settled. A related phenomenon may be the concentrations of midden material and artifacts that occur in squares with structural walls. It could not be determined whether these concentrations were found within the walls or beneath them.

Given the importance of the work conducted at Barber's Point, it would have behooved the authors to spend all available time and manpower pursuing the major thrust of the study: the recovery and analysis and interpretation of data relating to the prehistoric human habitation of the area. If the length of the various report segments are any indication of the relative efforts put into each, Appendix III seems to have been overemphasized. Though the historic period in the study area certainly has inherent interest in its own right, it appears that an inordinate and largely spurious amount of work was undertaken on the wartime history of the area. In relation to the archaeological work, Appendix III is, for the most part, irrelevant.

In general, the organization of the document is less than conducive to review. The lengthy scope of work and summary of results could more comfortably be placed elsewhere in the document. Certainly a summary is out of place in the first 20 pages of a report such as this. The scope of work more appropriately belongs in an appendix while the explication of the research design should build on preceeding discussions of previous and on-going research as well as the chapter on physical geography.

The intent of the various legislative madates for mitigation of impacts on sites eligible for inclusion on or listed on the National Register of Historic Places was to ensure that archaeological sites valuable for the information they contain were not destroyed as a result of Federally sponsored or licensed undertakings. Because mere collection and description of artifacts and midden and other raw data did not effectively mitigate impacts to archaeological sites, implementing regulations require interpretation and analyses of the data and material collected. The overiding, fundamental deficiency of the subject report is the appalling lack of synthesis, of integration of data collected during this project into a cohesive description of prehistoric human habitation in the Barber's Point area, and of scholarly, professional interpretation of the data collected. In our opinion, the report fails to fulfill the intent of the various Federal regulations and legislation under whose aegis the work was performed. The report does not fulfill the requirements of 36 CFR 66 (proposed) nor does it conform to generally accepted guidelines that the Advisory Council on Historic Preservation uses to evaluate reports produced under memoranda of agreement with that agency. For such a work, dealing with so significant an area, to reach its professional reviewers in so sloppy a state, reflects poorly both on the authors of the report and its sponsors.

So major are the revisions that must be undertaken to remedy the various deficiencies noted above, that we suggest that the Corps of Engineers reject the subject report as inadequate and require a completely rewritten draft report. The new draft should then be forwarded to the same reviewers for re-evaluation when it is completed. Should the Corps adopt this suggestion, the Society would appreciate receiving at least three copies of the document for review as well as a period of 30 days in which to review it.

Again we appreciate the opportunity to review and comment on this document. Should you have any questions regarding this review, you may contact the Society at the above address.

Sincerely,

Robert J. Hommon

Robert J. Hommon, Ph.D.
Chairman, Ad Hoc Committee to Review the
Hammatt/Folk Report on Barber's Point

October 21, 1981

Review of: Archaeological and Paleontological Investigation of Barbers Point, Federal Study Area Ia and Ib, and State of Hawaii Optional Area 1

by

Hallett H. Hammatt and William H Folk
with Appendices by five other researchers

When William Kikuchi left in my hands his copy of the above report, it was with the restriction that I would have only 30 days in which to review and "please not tell anyone you are previewing Dr. Hammatt's report."

I did not anticipate at the time the urgency of demand which would be made upon my time and energy during the next 30 days, with the result that I have had fewer hours than I would like to have had to study the report, I feel, at this moment, the last day of the 30 days, that I am sufficiently familiar with it to say that I can accept it as an all-comprehensive report of the studies to date and that I can agree on the recommendations.

I would like to have discussed this report with my colleagues at the museum, but have observed Kikuchi's wish.

What I can say is a commentary rather than a review. For a review I would want to discuss the whole area with my colleagues.

I see now that all the research and recording previous to Hammatt's and Folk's participation were essential to the thoroughness of their last report covering the area in question. Their report reveals that this area was being inhabited from very close to the beginning of Polynesian settlement on Oahu and that these settlers must have contributed to the early extinction of a number of birds, and to modifications of the vegetative cover. In view of what has happened in the study area in my time (since 1900) and what may happen now, it is most fortunate that we have the report prepared by Hammatt and Folk.

Kenneth P. Emory

Kenneth P. Emory
Senior Anthropologist
Bernice P. Bishop Museum

B I S H O P   M U S E U M

P.O. BOX 19000-A • HONOLULU, HAWAII 96819 • 808 847-3511

November 6, 1981

Mr. Kisuk Cheung
Pacific Engineer
Pacific Ocean Division
Corps of Enginees, Bldg. 230
Fort Shafter, Honolulu, Hawaii 96858

Re: Barbers Point Hearings

Dear Mr. Cheung:

(1) I must initially state that I have not been personally involved in the archaeological work at Barbers Point in the Deep Draft Harbor area. The first time I really read anything about it was when I received a copy of the Hammatt-Folk report (ARCH 14-115) from Dr. William Kikuchi with a request for a review.

(2) Under these circum-tances, I regret accepting the responsibility for writing a review, particularly in view of the fact that I was asked by Dr. Kikuchi not to "tell anyone" I was reviewing Hammatt's report. This precluded my seeking factual information from my colleagues at Bishop Museum who were the real experts on the archaeology of that area and had spent many months working in the field there, analyzing the data collected, and producing four excellent reports (1975, 1976, 1978 and 1979) with recommendations. The recommendations of the 1976 and 1979 reports have not been adequately followed.

(3) Since reading the reports in the Star-Bulletin of October 21, and November 4, 1981, on the hearings in connection with the Coral Stockpile Plan for Barbers Point, I regret the comment I made to the Corps of Engineers in which I said, "I can agree on the recommendations" made by Hammatt and Folk. This statement was made without benefit of my discussing the report with my colleagues and without my reviewing the Bishop Museum's reports. I just assumed Hammatt had followed them. Without making the necessary inquiries, I really have put myself in a position of not being qualified to say what I did in my commentary of October 21, 1981, to the Army Corps.

(4) Judging from the recommendations of the Bishop Museum's reports of 1976, 1978, and 1979 I now understand that the archaeological and palaentological potential for interpreting the flora and faunal environment of O'ahu as it existed before and after early Polynesian settlement, was far from exhausted and that we would be quite unjustified in supporting Hammatt's statement as given in the Star-Bulletin report of October 21, 1981, that "We don't feel in this area there's need for further field work" and "The sites are not suitable for physical preservation."

There were only two times I was personally involved in archaeology in the Barbers Point area. One was during the 1960s when Standard Oil Refinery was constructing pipelines and the existing barge harbor. At that time Mr. Lloyd Soehren and I observed burials in the coastal sand dune areas and a fishing shrine. The other was in 1933 to photography sites, one of which appeared to be a marae type structure. It is my understanding that these sites have now been destroyed.

(5) Given the above situation, I must retract my statement that I can agree with Hammatt's recommendations.

Kenneth P. Emory
Senior Anthropologist

Copy to: City and County Planning Commission.

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-8